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BIO-ASSAY INVESTIGATIONS

Croswell Henderson, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1956

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BIO-ASSAY INVESTIGATIONS

FOR

INTERNATIONAL JOINT COMMISSION

DONNER-HANNA COKE CORPORATION

BUFFALO, NEW YORK

1956

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Robert A. Taft Sanitary Engineering Center

Cincinnati, Ohio

Bio-assay Investigations

Donner-Hanna Coke Corporation

Buffalo, New York

Prepared by

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Buffalo, New York

INTRODUCTION

Purpose

In January 1956, field studies were initiated on a cooperative basis to determine the possible effects of industrial wastes from major Buffalo River industries on the eastern end of Lake Erie and the Niagara River. Buffalo River industries cooperating in this project were National Aniline Division-Allied Chemical and Dye Corporation, Donner-Hanna Coke Corporation, and Socony-Mobil Oil Company.

Part I of this report covers an investigation of the toxicity to fish of intake water and final effluent from the Donner-Hanna Coke Corporation. By-product coke wastes contain some chemical compounds which are known to be toxic to aquatic life in relatively low concentration. Some of these chemicals when mixed with or under the influence of other non-toxic

components of the effluent or receiving water may exert an entirely different toxicity from that of the pure compounds. Bio-assays were made to evaluate directly the toxicity of these chemically complex wastes.

The large variation in the toxicity of final effluent samples led to a further study at this plant. Bio-assays were used to trace sources of toxicity to various processes within the plant.

Part II of this report covers an investigation of the toxicity to fish of the various process wastes.

Personnel Participating

Donner-Hanna Corporation

Howard Heidenberg, Plant Superintendent

Pittman Smith, Asst. Plant Superintendent

John Knappert, Asst. Plant Superintendent

Donald Black, Engineer

Orhan Tarhan, Research Chemist

Cecil George, Plant Chemist

Public Health Service

Hayse H. Black, Industrial Wastes Consultant

Croswell Henderson, Aquatic Biologist

H. A. Anderson, Public Health Engineer

M. W. Ruszaj, Chemist

Organization of Study

Donner-Hanna Coke Corporation personnel collected samples of the intake water and effluents to be studies. The Public Health Service conducted the bio-assays in laboratory space provided by the National

Aniline Division in Buffalo. Analyses for phenol and cyanides were made in the Buffalo I.J.C. Unit Laboratory.

GENERAL INFORMATION

Production Operations

The Donner-Hanna Coke Corporation operates 251 ovens to produce blast furnace coke. By-products include gas, tar, ammonium sulfate, naphthalene, benzene, toluene, xylene, and pyridine.

The heavy and light tars produced are sold to the Koppers Company which operates a tar processing plant on the Donner-Hanna Coke Corporation property. The wastes from the Koppers Company plant are discharged into the main Donner-Hanna Coke Corporation sewer and are a part of the final effluent that enters the Buffalo River.

Ammonia is recovered from the coke gas by the semidirect process.

The coking period during this study was 15.7 hours with a flue temperature of 2500 degrees Fahrenheit.

The coke plant operations are on a continuous 24 hour day 7 day week basis.

Production

The daily production (24 hours) during the various periods of this study was relatively constant and was reported as follows:

Coal carbonized	4300 tons
Coke produced	3300 tons
Gas produced	49.5 million cubic feet
Light oil Produced	14500 gallons
Ammonium Sulfate	47 tons
Crude Tar	37000 gallons

Water Supply

Buffalo city water is used for drinking and sanitary purposes. It is also used to a very limited extent in the plant for such purposes as boiler feed water.

The major portion of plant water supply is Buffalo River water, purchased from the Republic Steel Corporation which pumps from a shore intake located on the south bank upstream from the Donner-Hanna sewer outfall. During periods of low river flow, recycling of the coke plant effluent may occur. Well water is used during the warm months, June to September, for cooling the bank of wash oil coolers in the benzol plant.

Waste Discharge

All of the process effluents from this plant and the wastes from the Koppers tar plant are combined into one waste stream (final effluent) in a 48" concrete sewer which is discharged into a ditch which runs through the Republic Steel Corporation property and then enters the Buffalo River.

Waste Control Measures

Waste control measures include the use of a Marley cooling tower and recirculation of final cooler water and the discharge of light oil decanter water to the final cooler water or quenching station instead of directly to the sewer.

A dephenolization plant was under construction during this study and has subsequently been placed in operation.

Sludges from the acid wash of crude benzol are hauled to a dump and do not enter the Buffalo River.

SURVEY METHODS

Chemical Methods

All chemical determinations were made according to procedures in "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes," 10th edition, published by the American Public Health Association.

Bio-assay Methods

Bio-assays were made, essentially, by the method recommended by the toxicity subcommittee of the Federation of Sewage and Industrial Wastes Associations (Sewage and Industrial Wastes, Vol. 23, No. 11, 1380, Nov. 1951). This method consists of preparing various concentrations of effluent in a selected dilution water, adding the test fish and observing their reactions over a definite time period. For ease in the plotting and interpreting of results it is desirable to make up test solutions with the percentage of effluent in a logarithmic series as 10, 5.6, 3.2, 1.8, 1.0, etc.

As the effluents were of unknown toxicity, exploratory or small scale tests were made to determine the approximate toxic range. Test solutions were prepared over a wide range of concentration (e.g., 100, 10, and 1.0 percent effluent). Two fish were added to 2 liters of each concentration in 6-1/2 inch diameter, 1 gallon wide mouth glass bottles. Observations for relatively short time periods indicated test concentrations necessary for the full scale experiments.

In the full scale tests, 10 fish were generally used for each test concentration. Five fish were added to 10 liter duplicate samples in 5 gallon widemouth glass bottles, 10 inches in diameter. The intermediate concentrations tested were dependent upon information obtained from the

exploratory tests. For example, if fish were killed in concentrations above 10 percent and not affected in concentrations of 1 percent, intermediates were set up within this range (e.g. 10, 5.6, 3.2, 1.8, and 1.0 percent concentration of effluent).

The dilution water used was raw Lake Erie water obtained at the Buffalo, N. Y., water plant. This water was hauled into the laboratory, allowed to come to room temperature, and aerated vigorously for at least one hour to bring it to equilibrium with atmospheric gases. Characteristics of this water at time of use were as follows: Dissolved oxygen 7.6-8.2 ppm; pH 8.0-8.2; total alkalinity ($CaCO_3$) 94-100 ppm; total acidity ($CaCO_3$) 0-1 ppm; versenate hardness ($CaCO_3$) 120-135 ppm.

The test fish used were fathead minnows (Pimephales promelas), ranging in length from 2 to 2-1/2 inches and in weight from 1 to 1-1/2 grams. These fish were obtained in uniform lots from the Newtown Ohio, Fish Hatchery and acclimated to laboratory conditions. This species is of intermediate tolerance to chemicals comparable to bass, sunfish, perch, and other warm water species, and will tolerate fairly low oxygen conditions (1-2 ppm).

Another species, the emerald shiner (Notropis atherinoides), obtained locally from a Buffalo bait dealer, was used in some experiments in order to obtain a comparison of the toxicity of the wastes under test to fatheads and this locally abundant species.

The bio-assays were made at ordinary laboratory temperatures which were within the range from 22 to 25° C. and compare favorably with maximum summer water temperatures in this area.

The tests were designed so that generally no oxygenation or aeration was needed. Absorption of atmospheric oxygen by the exposed water surface was normally adequate for fish requirements during the test period. However,

in some of the bio-assays, high oxygen demand effluents caused oxygen depletion. When necessary, dissolved oxygen was maintained by bubbling pure oxygen through the test solution by means of a suitable arrangement of valves and small tubing. The rate (60-180 bubbles per minute) was adjusted to maintain adequate oxygen for fish survival with minimum agitation in order to prevent the loss of volatile materials.

Physical and chemical determinations (temperature, dissolved oxygen, pH, alkalinity, and hardness) were made on each concentration initially, after fish mortality, or at the completion of the test. This was done primarily to detect low D.O. levels so they could be controlled and to differentiate between fish mortality due to oxygen deficiency or acidity and toxic properties.

Fish reactions were observed over a 96 hour period. From the mortality in different concentrations, 24, 48, and 96 hour TL_m (Median tolerance limit) values were obtained. The median tolerance limit is the concentration of effluent in dilution water that kills just 50 percent of the test fish. These values were obtained by straight line graphical interpolation from points representing percent survival of fish and log concentrations of effluents which bracketed the 50 percent point.

Effluents were normally brought into the laboratory in the afternoon immediately following collection and exploratory tests were set up at once. Observations made the following morning furnished information on the toxicity of the wastes essential for setting up the full scale tests.

PART I -- BIO-ASSAYS OF FINAL EFFLUENT AND RIVER INTAKE SAMPLES

Flow Measurements

Measurements of the final effluent flows were made by both the chloride addition method and by means of a current meter. Following are flow measurements obtained during the different periods of study:

Date	Method of Measurement	Measured Flow mgd
1-25-56	Chloride addition	7.45
3-21-56	Chloride addition	4.72
3-21-56	Current Meter	5.38
3-22-56	Current Meter	5.49
6-26-56	Current Meter	8.53
11-13-56	Chloride addition	6.57
11-15-56	Chloride addition	6.68
12-7-56	Current Meter	5.96
Average		6.35

The average flow of 6.4 M.G.D. or 9.85 cfs was used for all computations.

Sampling

During most of the study periods uniform portions of the final effluent were collected hourly beginning at 8:00 A.M. and composited for an 8 hour period. During the November studies a small pump was used to collect a continuous 8 hour composite.

Samples for phenol analysis were preserved with copper sulfate and those for cyanide analysis were preserved by the addition of sufficient sodium hydroxide to maintain a pH of 11 or above. Ten gallon samples of raw effluent were collected for the bio-assay studies.

RESULTS

Physical and Chemical Characteristics

A general description and some of the chemical characteristics of final effluent and river intake water samples are given in Table 1.

Samples of effluent were brown to grayish brown in color, turbid, and with a general appearance of containing some emulsified oil. Some samples had an oil scum on the surface. Odors were variable in intensity with some samples having a strong medicinal, oil, or solvent odor.

Dissolved oxygen values were low in all effluent samples. Some of the bio-assay test concentrations lost oxygen rapidly indicating a high oxygen demand.

Samples were normally alkaline with pH values ranging from 7.5 to 9.2. The lower values were obtained when there was no lime on the ammonia still.

Phenols ranged from a low of 6.7 ppm with the ammonia still off to a high of 46.5 ppm under normal operating conditions.

Cyanide concentrations were variable ranging from .02 to 0.58 ppm. There was apparently no definite relation to ammonia still operations as both high and low values were obtained under different operational conditions.

Compared to the effluent, river intake waters were generally less turbid, contained less odor, were at lower pH and higher D.O. levels, and contained less phenol and cyanide.

Characteristics of the effluent were somewhat dependent upon similar characteristics in the intake water as well as upon operational conditions.

TABLE 1 - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
Final Effluent (No lime on still)	1-19	Greenish-gray Medicinal Turbid	3.0	7.5	86	24	234	39.9	33.7	0.02
Final Effluent	2-13	Grayish-brown Very strong oil and medicinal Very turbid	4.6	9.0	200	0	240	46.5	48.7	0.17
	3-12	Light grayish-tan Medicinal and oil Turbid	1.4	9.1	74	0	275	27.7	24.4	0.58
Final Effluent (Still off)	3-14	Grayish-brown Gasoline, oil and medicinal Slight turbidity	3.4	9.2	100	0	135	6.7	6.2	0.03
Final Effluent (No lime on still)	3-20	Brown Oil and medicinal Turbid	4.8	7.8	100	44	155	35.2	37.4	0.49
Final Effluent	6-19	Brown Strong solvent and Oil. Turbid.	-	8.5	116	0	280	-	41.8	0.26
	6-25	Brown Oil and medicinal Turbid	4.0	8.6	84	0	300	36.8	-	0.28

TABLE 1 (Cont'd) - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
Final Effluent	11-13	Brown Solvent and oil Slight turbidity	-	8.1	94	4	460	-	-	-
	11-15	Brown Solvent and oil Slight turbidity	-	8.0	104	6	440	-	-	-
Final Effluent (No caustic wash)	11-16	Brown Solvent and oil Slight turbidity	-	7.9	92	6	430	-	-	-
River Intake Water	1-19	Greenish-gray Oil and phenol Turbid	6.0	6.8	74	30	245	1.12	0.77	<0.01
	1-20	Greenish-brown Oil and sewage Turbid	4.8	6.8	60	36	265	0.94	0.90	<0.01
	2-13	Light grayish-tan Faint oil and solvent. Slight turbidity	8.0	7.5	70	8	140	0.16	0.16	<0.01
	3-12	Grayish-tan Oil and gasoline Slight turbidity	9.6	7.5	52	4	105	0.01	0.02	0.01

TABLE 1 (Cont'd) - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
River Intake Water	6-19	Brown Faint solvent and oil Turbid	1.4	7.0	114	8	220	-	0.29	0.09
	6-25	Brown Faint oil and medicinal Turbid	1.6	7.4	90	12	180	0.60	-	0.04
	11-13	Dark brown Gasoline Slight turbidity	1.4	6.8	72	16	300	-	-	-
	11-15	Brown Faint gasoline Slight turbidity	0.9	7.2	90	14	320	-	-	-

Toxicity to Fish

A summary of bio-assay results showing the direct toxicity of the final effluent and river intake samples to fish is shown in Table 2. The information on which these results are based, including concentrations tested, time for fish mortality, percent of mortality, and bio-assay control data is shown in the Appendix.

Median tolerance limit (TL_m) values were obtained for 24, 48, and 96 hour periods. The 96 hour TL_m was used to compute the dilution ratio, which is the ratio of a unit volume of effluent to dilution water which produces a 50 percent mortality of the test fish. This ratio times the effluent flow gives the dilution volume or the total flow or volume of receiving water required to reduce the toxicity of the effluent to where a 50 percent mortality of the test fish is produced. The following formula may be used for directly computing this dilution volume:

$$\frac{100 - TL_m}{TL_m} \times \text{Effluent Flow} = \text{Dilution Volume}$$

The dilution volumes represent conditions which would cause direct injury to fish upon short time exposure and are a direct comparative measure of toxicity. Liberal application factors must be applied to these results for complete protection of aquatic life.

The toxicity of the wastes was variable with 96 hour TL_m values ranging from 2.9 to 22.5 percent.

The toxicity of samples taken with a continuous flow pump in November and December were less toxic than those taken previously. Several reasons may be advanced for this condition (1) hourly grab samples may not be

TABLE 2 - SUMMARY OF BIOASSAY DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Effluent Flow cfs	TLm (Median Tolerance Limit) (Per Cent Concentration) 24 Hr.	48 Hr.	96 Hr.	Dilution Ratio	Dilution Volume cfs
Final Effluent (No lime on still) (2)	1-19	9.85	13.5	13.0	13.0	1:6.7	66 (1)
	2-13	"	4.1	3.7	3.2	1:30.2	298
	3-12	"	7.7	7.5	7.5	1:12.3	122
(Still Off)	3-14	"	7.2	7.2	7.2	1:12.9	127
(No lime on Still)	3-20	"	13.5	13.5	13.5	1:6.4	63
	Shiners	"	7.5	7.5	7.0	-	-
	6-19	"	3.9	3.5	2.9	1:33.5	330
	6-25	"	11.0	9.1	9.1	1:10	98
	11-13	"	13.5	13.5	13.5	1:6.4	63
	11-15	"	14.0	14.0	14.0	1:6.1	60
(Small amount of Caustic Wash)	11-16	"	22.5	22.5	22.5	1:3.4	33
(No Caustic Wash)	12-6	"	13.5	12.3	12.3	1:7.1	70
	12-6	"	14.3	12.0	12.0	1:7.3	72
(No Caustic Wash)	12-7	"	>18	15.5	15.5	1:5.4	53
	12.7	"	15.5	12.8	8.0	1:11.5	113
AVERAGE		9.85			11.0		112

(1) Dilution volumes computed with intake toxicity subtracted.

(2) Except where specified, normal operations were with lime on still and 2 batches of caustic wash during the 8 hour sampling period.

TABLE 2 (Cont'd) - SUMMARY OF BIOASSAY DATA
DONNER-HANNA EFFLUENTS

Source	Date 1956	Effluent Flow cfs	TLm (Median Tolerance Limit) (Per Cent Concentration) 24 Hr.	48 Hr.	96 Hr.	Dilution Ratio	Dilution Volume cfs
River Intake Water	1-19	9.85	79	70	69	1: .45	4.45(1)
	1-20	"	60	51	51	1:1	9.85
	2-13	"	100% Surv.	100% Surv.	100% Surv.(2)	-	-
	3-12	"	100% Surv.	100% Surv.	90% Surv.	-	-
	6-19	"	29	29	29	1:2.4	23.6
	6-25	"	62	42	29	1:2.4	23.6
	11-13	"	51	51	51	1:1	9.85
	11-15	"	80% Surv.	60% Surv.	60% Surv.	-	-
AVERAGE		9.85			60		9.0

(1) Dilution volumes computed with intake toxicity subtracted.

(2) Per cent survival of fish in untiluted sample.

representative -- some of the batch effluents that are released during a short time period may not be sampled proportionately; (2) the very small waste stream from the pump exposed to the air may have increased loss of volatile toxicants; and (3) the diversion of light oil decanter to the west sump may have reduced or eliminated the overflow from the gas final cooler system.

Oxygen depletion occurred rapidly in some of the higher bio-assay test concentrations. Pure oxygen was added to these concentrations in order to maintain a supply adequate for fish. It was thus possible to distinguish readily between fish mortality due to oxygen depletion and that from toxic materials.

River intake waters were also toxic to fish except during high flow periods but to a much lesser degree than the effluent samples.

SIGNIFICANCE OF DATA

Characteristics which may affect Aquatic Life

While bio-assays have shown the final effluent to be toxic to fish, insufficient information was available to indicate the major components responsible.

Bio-assays conducted on phenol and ortho-cresol under experimental conditions similar to that of the effluent gave 96 hour TL_m values of 40 and 24 p.p.m., respectively. Thus, phenol would account for only a portion of the toxicity found. Other phenolic compounds, especially some of the chlorophenols, have been reported toxic to fish in concentrations as low as 0.1 p.p.m.

Bio-assays with cyanide gave a 96 hour TL_m value of 0.24 p.p.m. (CN) and while enough cyanide was present in some effluent samples to produce

fish mortality, only a small amount of the toxicity found could be attributed to cyanide.

Bio-assays with other chemicals known to be in coke plant effluents gave the following information:

Chemical	96 hr. TL_m p.p.m.
Ammonia (N)	7
Sulfides (H_2S)	1.4
Benzene	56
Toluene	51
Xylene	28

Chemical information was not available on the amount of the above materials in these effluent samples. Previous information on similar samples had indicated that these chemicals were not present in sufficient amounts to account for the high toxicity in the effluent samples.

The inability to identify major toxic components in this highly complex waste and the large variability in the toxicity of different composite samples led to the study described in part II of this report in which bio-assays were used to trace sources of toxicity to process wastes.

The pH values of these effluent samples were at levels which would not be expected to have any adverse effect on aquatic life; normally pH values below 5 and above 9 may have a direct lethal effect. Within these limits, however, a change in pH may have an effect by increasing or decreasing the toxicity of various chemicals to fish. The toxicity of metal salts, cyanides, and sulfides may be greatly increased by a decrease in pH while the toxicity of ammonia is greater at the higher pH values. An increase

or decrease in pH may also have an effect not only on materials released in these effluents but also on those released by other industries and present in the receiving waters. A few experiments conducted during this study indicated a reduction in toxicity when this effluent was mixed with that from other industries in the Buffalo River basin.

Oxygen depleting characteristics may have a definite effect on aquatic life unless adequate volumes of receiving water are available for dilution or assimilation. For protection of aquatic life dissolved oxygen concentrations should be maintained at 5 ppm or above in waters receiving toxic materials.

The release of hot effluents which may increase temperatures in receiving waters may increase the toxicity of some materials, reduce dissolved oxygen, and raise temperatures above the optimum tolerance levels of some aquatic organisms.

Sub-lethal concentrations of phenols and benzene derivatives are known to impart a taste to fish flesh.

Effect on Receiving Waters

All samples of final effluent were toxic to fish. The dilution volumes necessary to reduce this toxicity to the levels producing a 50 percent mortality of the test fish (Table 2) would obviously not provide for complete protection of aquatic life. To attain this aim liberal application factors must be used, which are based on the following major considerations: (1) The bio-assay procedure measures 50 percent mortality during a relatively short time period in non-renewed solutions. This must be related to concentrations having no effect during continuous long time exposure.

(2) Test data apply directly to the species of fish used. While fathead minnows are of intermediate tolerance and compare favorably with many warm water "game" fishes, some locally important species of fish and fish food organisms may be more sensitive. Bio-assays conducted with a locally important forage fish, the emerald shiner (Notropis atherinoides), indicated this species was approximately twice as sensitive as fathead minnows.

(3) Some effluents may vary in toxicity. A few samples may give an indication of toxicity but maximum conditions may be missed. In many situations, maximum conditions of toxicity are the limiting factor as far as aquatic life is concerned.

(4) Some conditions which may generally reduce but in some cases increase the magnitude of the application factor are the loss of volatiles, hydrolysis, oxidation, precipitation, and changes in water quality characteristics by the entrance of other effluents.

Based on the best available information an application factor of at least 3 would be necessary to prevent fish kills and as much as 10 for complete protection and propagation of fish. It is evident that low seasonal flows in the Buffalo River would not provide this necessary dilution; however, only a small portion of the Niagara River flow would be necessary.

The contribution of toxicity to the Buffalo River by the Donner-Hanna effluent adds to that present from other industries in the basin. While the toxicity from individual industrial effluents is substantially reduced in the basin, enough remains to present a threat to the Niagara River under abnormal conditions. Toxicity builds up in the Buffalo River during low flows and then may be rapidly flushed into the Niagara River. Additional dilution water in the Buffalo River during low flow periods should minimize this possibility.

Depletion of oxygen was observed in various concentrations of effluent during the bio-assays. As these concentrations may be exceeded in the Buffalo River during low flows, oxygen depletion would no doubt occur in the river. This would not significantly affect the Niagara River but may have an effect in a border zone where the Buffalo River enters Lake Erie.

The possibility also exists that an off-flavor in fish flesh may be produced by small quantities of phenols, solvents, or other chemicals.

CONCLUSIONS

Bio-assays have shown that all samples of final effluent were toxic to fish. The toxic components were not identified. Buffalo River intake samples were generally toxic but to a much lesser degree.

Some oxygen depletion was apparent in high concentrations of final effluent during the 96 hour test period. All of the samples, however, were toxic in concentrations that retained adequate oxygen for fish support.

This effluent contributes toxicity to the Buffalo River and adds substantially to that contributed by other industries in the basin. Seasonal low flows in the Buffalo River do not provide for adequate dilution of these wastes. Under normal flow conditions, however, little or no affect on aquatic life in the Niagara River would be expected.

The buildup of toxicity in the Buffalo River basin during low flows, with the possibility of a rapid release into the Niagara River under abnormal conditions does present some threat to aquatic life in the Niagara. Additional

dilution water in the Buffalo River during low flows should minimize this possibility.

As long as large quantities of unknown toxic materials are entering the Buffalo River basin, the threat to aquatic life in the Niagara River cannot be completely eliminated. The bio-assay information contained in Part II of this report may be used to help in further reducing or eliminating the major toxic wastes.

PART II - BIO-ASSAYS OF PROCESS EFFLUENTS

Introduction

A large variation in the toxicity of final effluent samples led to a further study at this plant. Chemical information available from current and previous studies gave no indications as to which components were major contributors of toxicity. Only a small part of the toxicity in the final effluent could be accounted for from known components such as phenols, cyanides, ammonium compounds, and sulfides.

Bio-assays were used to evaluate the toxicity of process waste streams within the plant in order to trace major sources of toxicity to their origin.

Process Wastes

The major waste streams known to enter the final effluent were the ammonia still wastes, quench water, wastes from the Koppers tar plant, and wastes from the light oil recovery and refining plant which entered the so-called east and west sumps.

There were intermittent overflows of the gas final cooler recirculating water into the main sewer.

The usual practice at this plant is to discharge part of the light oil decanter water to the final cooler recirculating system and part to the west quenching station. During the tests conducted on November 13 and 15 and on December 6 and 7, this waste was temporarily diverted into the west sump in order to even out flows for more adequate sampling, to provide for better flow measurements and to reduce the possibility of overflow of final cooler recirculating water to the sewer during the test period.

Initial bio-assay studies on the above waste streams conducted in June 1956, indicated that a large part of the toxicity was contributed by the west sump. Further studies in November included samples from the waste streams entering this sump; namely, the BTX caustic wash, the residue boiler column drain and some miscellaneous condensates from the benzol stills. Flow diagrams indicating all of the above waste sources are shown in Figures 1 ard 2.

The influent to the east sump consists primarily of cooling water from the indirect coolers in the benzol plant. The east sump is essentially a gravity oil separator designed to collect any oils lost in the event of leaks developing in the coolers. This effluent is discharged to the main sewer.

The waste designated as caustic wash is the liquid waste resulting from batch washing of crude benzol (BTX mixture) with a strong caustic solution.

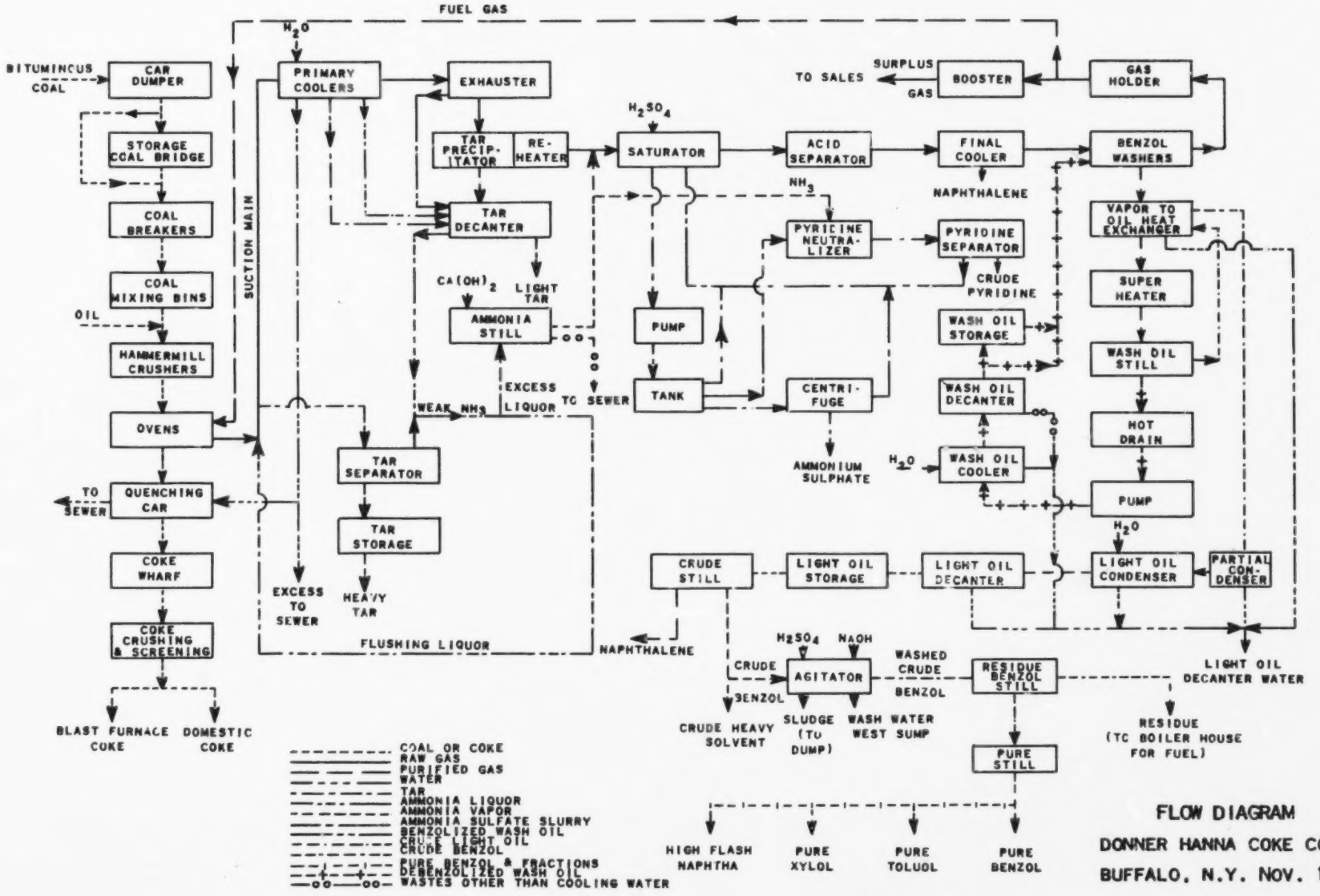
The residue boiler column drain is the residual liquid phase removed from the fractionating column during the steam distillation of the BTX mixture, excluding some heavy residues which are decanted in a separator and burned as fuel.

The miscellaneous benzol plant waste includes residue boiler decanter water, steam trap discharges, and floor washings from the tank house.

The above three wastes, along with the light oil decanter water, as described previously, enter the west sump. This sump is a gravity oil separator which discharges its effluent into the main sewer.

Effluent Flows

Measurement of flows of the process effluents was made by various methods as described below.

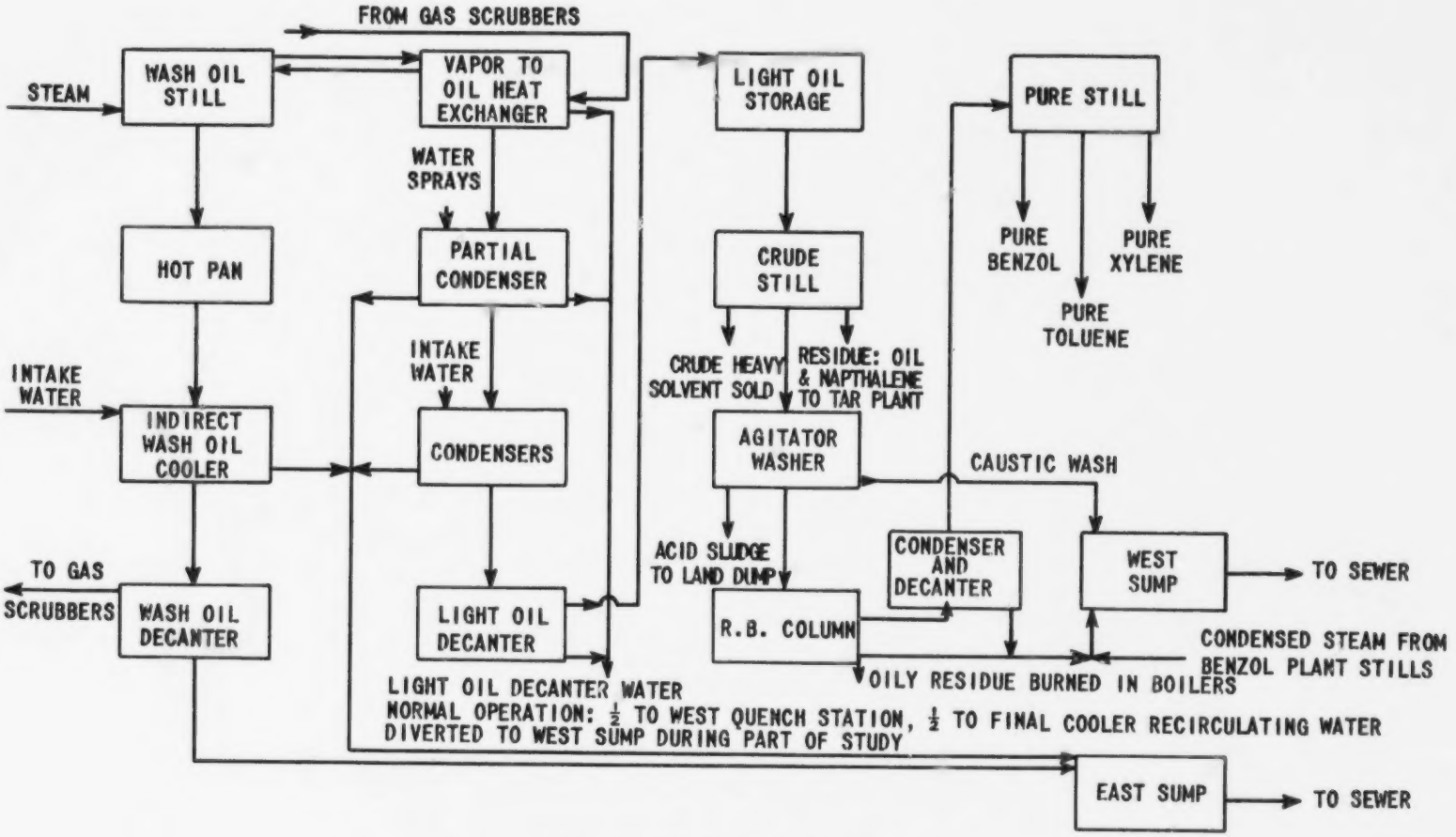


FLOW DIAGRAM

DONNER HANNA COKE CORP.

BUFFALO, N.Y. NOV. 1956

FIGURE 1



SIMPLIFIED FLOW DIAGRAM

LIGHT OIL RECOVERY AND REFINERY SHOWING WASTES TO EAST AND WEST SUMPS

DONNER HANNA COKE CORP.

NOV. 1956

Figure 2

The volume of ammonia still wastes was calculated using the measured rate of feed to the still and a chloride balance in the feed and effluent. Measurements were made during the periods November 12 to 16 and December 6 and 7. The average volume computed was 0.134 M.G.D.

The quench water was estimated on the basis of the use of 5500 gallons of water per quench with a 20 percent evaporation loss and 384 quenches per day. The average volume computed was 1.89 M.G.D.

Tar plant wastes were estimated by totalling the metered water intake, water in tar processed, and steam directly introduced into the still. Measurements were taken during the November sampling period and averaged 0.448 M.G.D.

Effluent from the east sump was measured by considering the discharge section as a sharp crested rectangular weir and using Francis' formula, $Q = 3.33\ LH^{3/2}$ for the computation. The flow from a weir measurement taken on November 15, was 1.62 M.G.D.

The volume of light oil decanter water was determined by timing the filling of a container of known volume with a stopwatch. The average measurement during the period November 12 to 16, was 0.086 M.G.D.

The miscellaneous benzol plant wastes were measured by means of a 90° V-notch weir installed in a sewer manhole. The average of measurements taken during the periods November 12 to 16 and December 6 and 7, was 0.077 M.G.D.

The caustic wash volume was determined by measuring the quantity in the tank before discharge. This effluent is batch discharged daily to the west sump over a period not exceeding 30 minutes, usually at about 2:00 P.M.

Volumes of approximately 350 and 700 gallons are normally discharged on alternate days. The average measured discharge for five days during November and December when effluent samples were taken was 705 gallons.

The residue boiler column drain was also measured in the tank before discharge. One batch of approximately 700 gallons of this waste is discharged to the west sump during each 8 hour shift over a period which may vary from 15 to 30 minutes. The average of seven samples discharged in November and December was 755 gallons.

The above flows totalling 4.26 M.G.D. represent the major sources of toxic wastes. Primary cooler water in excess of that used for quenching flows directly to the sewer. Booster condenser water, estimated at 0.5 M.G.D. likewise goes to the sewer. Exploratory bio-assays showed these two effluents to be non-toxic to fish. The difference in flows between the final effluent (6.4 M.G.D.) and the measured process wastes was attributed to the excess primary cooler water.

Measurements were made for some miscellaneous process effluents which entered some of the above process waste streams. The wash oil decanter water was measured at 5.2 G.P.M. and the tar plant decanter discharge at 28.8 G.P.M. These measurements were made with a stopwatch and measured container.

Sampling

Most of the process effluents were collected by taking samples hourly and compositing over an 8 hour period. BTX caustic wash and residue boiler column drain samples were obtained by collecting portions about every 30 seconds during the period of discharge. West sump samples were collected every 15 minutes and composited over an 8 hour period.

Sampling was arranged so that major process waste and final effluent samples were collected simultaneously during one 8 hour period and west sump component and miscellaneous samples on alternate days.

RESULTS

Physical and Chemical Characteristics

A general description and some of the chemical characteristics of process effluent samples are shown in Table 3.

The general appearance of quench water and the east sump effluents was quite similar to that of Buffalo River intake samples. Other effluents were variable with respect to color and odor but were generally turbid and highly odoriferous. Colors varied from a white milky emulsified oil appearance in the residue boiler column drain to a black heavy viscous caustic wash.

Dissolved oxygen was absent in all effluents except the quench water and east sump.

The ammonia still wastes were strongly alkaline (except in one sample when no lime was used) as were the residue boiler column drain and caustic wash. Other effluents were slightly alkaline (pH 7.1-8.4). One west sump sample was somewhat acid (pH 5.3).

Phenols were by far the highest in ammonia still wastes. Tar plant wastes and light oil decanter water also contained appreciable quantities. Other effluents contained only slightly more phenols than intake water samples.

Cyanides were also highest in ammonia still wastes and light oil decanter water. Concentrations in tar plant wastes were somewhat less while other effluents contained little if any more than river intake samples.

TABLE 3 - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
Ammonia Still Waste	3-12	Dark brown Medicinal Turbid	0.0	9.7	2120	0	8770	386.4	392.2	1.37
Ammonia Still Waste (No lime)	3-13	Dark brown Medicinal Turbid	0.0	7.6	190	650	130	820.2	-	1.10
Ammonia Still Waste	6-25	Very dark brown Medicinal and tar Turbid	0.0	11.3	1520	0	8800	649.5	-	1.02
	11-13	Dark Brown Faint Tar and Coal Gas. Turbid.	-	9.2	1530	0	-	-	-	-
	11-15	Dark Brown Faint Tar and Coal Gas. Turbid.	-	9.8	1330	0	9540		-	-
East Quench	6-25	Dark Brown Faint Coal Gas Turbid	3.6	8.0	78	2	240	1.0	-	0.03
West Quench (Includes 1/2 Light Oil Decanter Water	6-25	Dark Brown Faint Coal Gas Turbid	1.0	7.4	96	8	235	27.2	-	0.05

TABLE 3 (Cont'd) - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
West Quench	11-13	Dark Brown Faint Coal Gas Slight Turbidity	2.0	7.4	74	10	330	-	-	-
	11-15	Brown Faint Coal Gas Slight Turbidity	3.0	[illegible]	80	10	345	-	-	-
Tar Plant	6-25	Black Tar Slight Turbidity	0.0	8.1	112	1	210	86.1	-	0.50
	11-13	Very Dark Brown Solvent Turbid	-	7.1	88	20	285	-	-	-
	11-15	Black Solvent Turbid	-	8.2	138	0	305	-	-	-
East Sump	6-25	Brown Faint Medicinal Slight Turbidity	3.8	7.1	110	8	225	0.52	-	<0.01
	11-13	Brown Faint Gasoline Slight Turbidity	2.0	7.4	110	12	315	-	-	-
	11-15	Light Grayish-Tan Faint Coal Gas Slight Turbidity	2.8	7.1	118	12	305	-	-	-

TABLE 3 (Cont'd) - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
West Sump	6-25	White Emulsified Oil. Strong benzene. Very turbid.	-	11.2	325	0	40	3.9	-	<0.01
	11-13	White Emulsified Oil. Strong solvent. Very turbid.	-	9.2	125	0	125	-	-	-
	11-15	White Emulsified Oil. Strong solvent. Very turbid.	-	5.3	-	80	225	47.0	-	-
Light Oil Decanter Water	6-25	Light Tan Coal Gas Odor Some Emulsified Oil	0.0	7.7	36	6	65	66.7	-	2.60
	11-13	Almost Clear (Whitish cast). Strong Coal Gas and Solvent. Some Emulsified Oil.	-	8.2	50	4	110	-	-	-
	11-16	"	-	8.5	58	0	110	52.2	-	-
Residue Boiler Column Drain	11-12	Thick, White, Creamy Coal Gas Odor Emulsified Oil	-	10.6	290	0	45	-	-	-
	11-16	"	-	10.5	310	0	170	0.71	-	-
	12-7	"	-	10.8	160	0	40	-	-	-

TABLE 3 (Cont'd) - PHYSICAL AND CHEMICAL DATA

DONNER-HANNA EFFLUENTS

Source	Date 1956	Description Color, odor, etc.	Dissolved Oxygen ppm	pH	Alkalinity ($CaCO_3$) ppm	Acidity ($CaCO_3$) ppm	Hardness ($CaCO_3$) ppm	Phenols ppm 4AA	Phenols ppm Gibbs	Cyanide ppm
BTX Caustic Wash	11-12	Black, Thick, Viscous. Strong Solvent Odor	-	11.5	-	-	-	2.0	-	-
	11-16	"	-	11.5	-	-	-	1.8	-	-
	12-7	"	-	11.9	8800	0	350	-	-	-
Miscellaneous West Sump	11-12	Light Grayish Tan. Faint Coal Gas. Slight Turbidity.	-	8.4	75	0	90	-	-	-

Toxicity to Fish

A summary of bio-assay results showing the direct toxicity of major process effluents to fish is shown in Table 4. The data on which these results are based is shown in the appendix. Twenty-four, 48, and 96 hour TL_m values and dilution volumes computed as described in Part I are shown. All of the values are computed on the basis of samples taken during the 8 hour day shift. The most toxic effluent and the major contributor of toxicity to the final effluent was the west sump followed by the ammonia still and then the tar plant. The toxicity of samples of ammonia still wastes when no lime was used did not vary significantly from those with lime on the still. Quench water contributed only a small amount of toxicity while the east sump was even less toxic than the Buffalo River intake water.

The toxicity of process effluents which enter the west sump are shown in Table 5. The major contributors of toxicity to the west sump are the caustic wash and the residue boiler column drain. A significant amount is contributed by the light oil decanter water and a very small amount by the miscellaneous condensates. As these samples were taken during the day shift when all caustic wash was released, the contribution of toxicity from this effluent appears greater than would actually occur during a 24 hour period.

The toxicity of the gas final cooler recirculating water and some miscellaneous process wastes which enter other waste streams is shown in Table 6.

Significance of Data

A schematic diagram showing the toxicity of process wastes and the percentage contribution of toxicity of each to the final effluent is shown

TABLE 4 - SUMMARY OF BIOASSAY DATA

DONNER-HANNA - MAJOR PROCESS EFFLUENTS

Source	Date 1956	Effluent Volume mg/8 hrs.	TLm (Median Tolerance Limit) (Per Cent Concentration 24 Hr.	48 Hr.	96 Hr.	Dilution Volume mg/8 Hrs.
Ammonia Still	3-12		2.10	1.35	1.30	
8 Hr.Composite	3-13		1.35	1.00	1.00	
	6-25		1.35	1.25	1.00	
	11-13		1.25	1.10	0.90	
	11-15		1.60	1.35	1.35	
AVERAGE		0.045			1.16	3.79(1)
Quench Water	6-25		42	37	37	
8 Hr.Composite	11-13		42	42	42	
	11-15		75	75	70	
AVERAGE		0.63			50	0.21
Tar Plant	6-25		7.5	7.5	7.5	
8 Hr.Composite	11-13		7.0	7.0	7.0	
	11-15		7.5	7.5	7.5	
AVERAGE		0.149			7.3	1.80
East Sump	6-25		87	64	64	
8 Hr.Composite	11-13		75	75	75	
	11-15		100% Surv.	100% Surv.	100% Surv.(2)	
AVERAGE		0.540			80	0
West Sump (Includes Light Oil Decanter Water)	6-25		0.30	0.30	0.30(3)	
	11-13		1.25	0.80	0.75	
8 Hr.Composite	11-15		0.64	0.37	0.37	
AVERAGE		0.055			0.47	11.60

(1) Dilution volumes computed with intake toxicity subtracted.
(2) Per cent survival in undiluted effluent.
(3) Computed to include light oil decanter water.

TABLE 5 - SUMMARY OF BIOASSAY DATA

DONNER-HANNA - WEST SUMP COMPONENTS

Source	Date 1956	Effluent Volume mg/8 hrs.	TLm (Median Tolerance Limit) (Per Cent Concentration) 24 Hr.	48 Hr.	96 Hr.	Dilution Volume mg/8 hrs.
West Sump (Miscellaneous)	11-12	.026	20	14.5	14.5	0.15
Light Oil	6-25		2.4	2.4	2.4	
Decanter	11-12		4.2	4.2	4.2	
Water	11-16		2.4	2.0	2.0	
AVERAGE		.029			2.9	0.95
Residue Boiler	11-12		.042	.020	.020	
Column Drain	11-16		.024	.013	.013	
	12-7		.029	.026	.025	
AVERAGE		.000755			.019	3.95
BTX Caustic	11-12		.0068	.0046	.0046	
Wash	11-16		.0075	.0070	.0062	
	12-7		.0066	.0062	.0062	
AVERAGE		.000705			.0057	12.30

TABLE 6 - SUMMARY OF BIOASSAY DATA

DONNER-HANNA - MISCELLANEOUS PROCESS EFFLUENTS

Source	Date	TLm (Median Tolerance Limit (Per Cent Concentration) 24 Hr.	48 Hr.	96 Hr.
Gas Final Cooler Water	6-25	1.10	0.70	0.70
	11-12	0.42	0.42	0.42
	11-16	0.24	0.24	0.24
	12-11	0.24	0.24	0.24
AVERAGE				0.40
Wash Oil Decanter	11-10	18	13.5	13.5
Residue Boiler Decanter	11-30	1.35	1.35	1.35
Tar Plant Decanter	11-30	0.135	0.135	0.135
Creosote Plant Decanter	12-17	1.0	1.0	1.0
Primary Cooler Water	6-25	100% Surv.	100% Surv.	100% Surv.(1)
Booster Condenser Water	6-25	100% Surv.	100% Surv.	100% Surv.

(1) Percent survival of fish in undiluted effluent.

in Figure 3. All of these values are computed from 8 hour day shift samples. The flows are given in million gallons during this period.

All TL_m values for process effluents are averages for the samples taken during June, November, and December. The intake and final effluent values are for corresponding samples taken during the same periods.

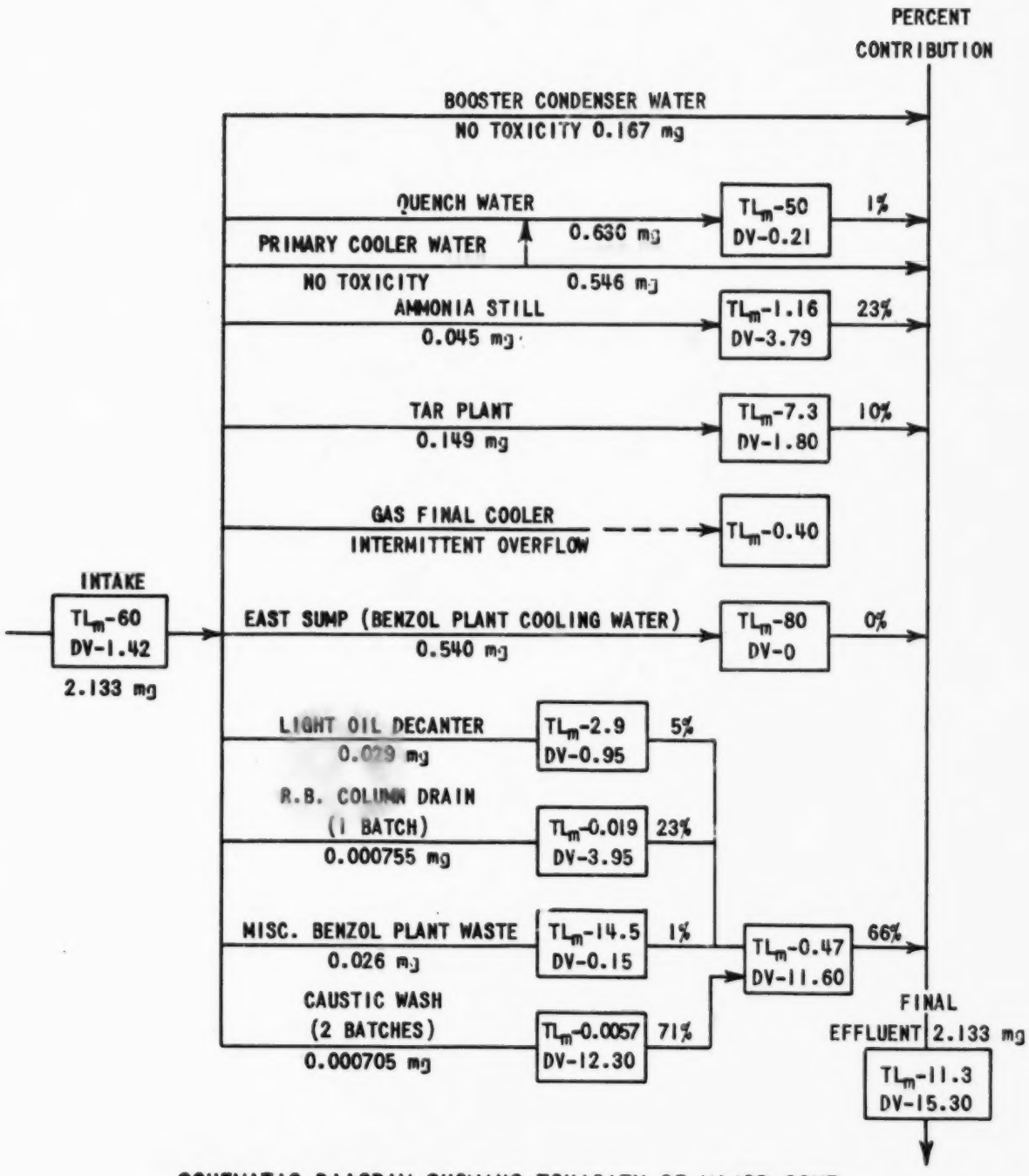
The Dilution Volumes are computed directly from the TL_m and flow values given with the intake toxicity subtracted.

As can be readily seen from this diagram, a large part of the toxicity is contributed by the west sump. The west sump dilution volume values, however, are less than those contributed by the process wastes that enter this sump. Practically all of the toxicity to the west sump is contributed by the caustic wash and the residue boiler column drain. As these wastes are known to contain highly volatile toxic materials, some of this difference is assumed to be due to loss of these volatile toxicants.

The ammonia still waste contributes a considerable amount of toxicity and the tar plant a lesser quantity. The quench water contributes only a small amount of toxicity.

The east sump wastes are actually less toxic than Buffalo River intake water. As this effluent is principally cooling water this is probably due to the loss of some toxic materials when this water is passed over tubular coolers (oxidation), and the temperature is raised.

The contribution of toxicity by the caustic wash as shown in this diagram, is excessive. The average volume of this material normally released during a 24 hour period is actually less (525 gallons) than the amount released during the 8 hour sampling periods.



SCHEMATIC DIAGRAM SHOWING TOXICITY OF MAJOR COKE PLANT WASTES DISCHARGED TO SEWER DURING AN 8 HOUR PERIOD

Figure 3

The estimated contributions of toxicity from each of the process effluents on a 24 hour basis is shown in Table 7. The reduced amount of caustic wash and the loss of volatiles in the west sump are taken into account in computing these values.

Conclusions

The process effluents which are the major contributors of toxicity in the final effluent from this plant are the ammonia still wastes, the residue boiler column drain, and the caustic wash.

Phenols and cyanide can account for a large portion of the toxicity in the ammonia still wastes. The dephenolization plant should reduce the toxicity of this waste considerably.

Caustic wash and residue boiler column drain are small volume effluents but highly toxic. The toxicity of the final effluent would be considerably reduced if these effluents were eliminated.

While very little is known chemically about the caustic wash, it appears that approximately 20 percent volatile materials may be recovered leaving a sludge which could be disposed of on a dry dump and may even be burned.

The residue boiler column drain appears to be an emulsion which breaks to some extent on standing. With proper treatment, this emulsion may be broken and toxic components either recovered or disposed of other than in the final effluent.

With present waste disposal measures, including the dephenolization plant and with additional measures to dispose of the caustic wash and residue boiler column drain, the toxicity of the final effluent should be greatly reduced.

TABLE 7

COMPARATIVE TOXICITY OF COKE PLANT WASTES DISCHARGED

DURING A 24-HOUR PERIOD

Effluent	Volume m.g.d.	96-hour TL_m Per Cent Concentration	Dilution Volume[1] 50% Mortality 24 hrs. m.g.d.	Dilution Volume[1] 50% Mortality Per 1000 Tons of coal coked	% of Total	% Contributed to Final Effluent
Quench Water	1.89	50	0.63	0.15	2	2
Primary Cooler	1.64	No tox.	0	0	0	0
Booster Condenser	0.50	No tox.	0	0	0	0
Ammonia Still	0.134	1.16	11.37	2.65	27	35
Tar Plant	0.448	7.3	5.40	1.26	13	15
Gas Final Cooler	-	0.40	-	-	-	-
East Sump	1.62	80	0	0	0	0
Lt.Oil Decanter	0.086	2.9	2.85	0.66	7	5
R.B.Col. Drain	0.002265	0.019	11.85	2.76	28	24
Caustic Wash	0.000525	0.0057	9.22	2.14	22	18
Misc.Benzol Plant	0.077	14.5	0.45	0.10	1	1
Process Effluents Total			41.77	9.72	100%	100%
Final Effluent	6.4	11.3	46.0[2]	10.7		
Intake	6.4	60	4.2	-	-	-

(1) Dilution Volumes computed with intake toxicity subtracted.

(2) Final effluent figures are high as composite samples were taken when larger amounts of caustic wash were being released.

APPENDIX

TABLE A1 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Final Effluent	1-19-56	100										Effluent	23	3.0	7.5	86	24	234	Greenish-grey Medicinal odor Turbid
8-Hr.Composite																			
(No lime on still)		32	10	20	30 min	30 min	45 min	0	0	0	0	Initial		6.0	7.8	94	8	158	
In Lab												45 min		6.0	7.8	96	10	160	
5:00 PM 1-19		18	10	20	2 hrs	6 hrs	10 hrs	0	0	0	0	Initial		6.4	8.0	96	4	146	
Fish Added												10 hrs		4.6	7.8	96	8	150	
11:30 AM 1-20		10	10	20	31 hrs	-	-	100	80	80	80	Initial	23	7.2	8.1	94	2	136	48 hr.D.O. - 2.0
												96 hrs	23	3.0	7.5	96	8	140	
		5.6	10	20	-	-	-	100	100	100	100	Initial		7.6	8.1	94	2	132	
												96 hrs		3.0	7.5	94	8	130	
		Control	10	20	-	-	-	100	100	100	100	Initial		7.6	8.2	94	1	122	
												96 hrs		5.6	7.7	100	2	125	
		TLm (Median Tolerance Limit) - Per cent Concentration						13.5	13	13	13								
Final Effluent	2-13-56	100										Effluent	25	4.6	9.0	200	0	240	Greyish-brown Very strong oil and medicinal odor Very turbid-Emulsified oil appearance Oil scum on surface
8-hr.Composite																			
In Lab		32	10	20	30 min	1 hr	1 hr					Initial	25	5.0	8.5	100	0	160	
4:00 PM 2-13												1 hr		6.0	8.5	96	0	165	
Fish Added		18	10	20	1 hr	2 hrs	2 hrs	0	0	0	0	Initial		6.6	8.4	100	0	150	
12:00 N 2-14												2 hrs		6.6	8.4	96	0	150	
		10	10	20	4 hrs	6 hrs	6-21 hrs	0	0	0	0	Initial		6.6	8.3	100	0	135	
												21 hrs		3.0	7.7	96	6	145	
		5.6	10	20	4-19 hrs	4-19 hrs	24 hrs	0	0	0	0	Initial		7.0	8.3	96	0	140	
												24 hrs		2.4	7.5	100	8	140	
		3.2	10	20	15-23 hrs	56-72 hrs	-	90	70	50	50	Initial	25	10.0	8.1	98	1	140	48 hr.D.O. - 3.4
												96 hrs	25	2.8	7.5	102	6	140	
		Control	10	20	-	-	-	100	100	100	100	Initial		7.6	8.2	96	1	135	
												96 hrs		4.2	7.7	100	4	130	
		TLm (Median Tolerance Limit) - Per cent Concentration						4.1	3.7	3.2	3.2								
Final Effluent	3-12-56	100										Effluent	23	1.4	9.1	74	0	275	Light greyish-tan Medicinal and oil odor Turbid
8Hr.Composite																			
In Lab		32	5	10	1 hr	1 hr	1 hr	0	0	0	0	Initial	23	6.8	8.5	96	0	185	
5:00 PM 3-12												1 hr		7.0	8.5	100	0	180	
Fish Added		18	10	20	4 hrs	5 hrs	6 hrs	0	0	0	0	Initial		7.2	8.4	92	0	175	
10:00 AM 3-13												6 hrs		7.0	8.3	96	0	170	
		10	10	20	8 hrs	8-32 hrs	33 hrs	10	0	0	0	Initial		7.4	8.4	92	0	160	
												33 hrs		3.2	7.7	92	4	140	
		5.6	10	20	-	-	-	100	100	100	100	Initial	23	7.2	8.3	92	0	140	
												96 hrs	24	3.4	7.7	94	8	135	
		3.2	10	20	-	-	-	100	100	100	100	Initial		8.0	8.2	94	1	130	
												96 hrs		4.2	7.7	98	6	130	
		TLm (Median Tolerance Limit) - Per cent Concentration						7.7	7.5	7.5	7.5								

APPENDIX TABLE A2 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	P H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Final Effluent	3-14-56	100										Effluent	23	3.4	9.2	100	0	135	Grayish brown Gasoline, oil, and medicinal odor Slight turbidity
8 hr. Composite																			
(Still eff)		32	2	2	1 hr	1 hr	1 hr	0	0	0	0	Initial		-	-	-	-	-	
In Lab																			
5:00 PM 3-14		18	5	10	2 hrs	2 hrs	2 hrs	0	0	0	0	Initial		7.4	8.6	96	0	125	
Fish Added												2 hrs			8.3	92	0	130	
12:00 N 3-15		10	10	20	5 hrs	5-20 hrs	5-20 hrs	0	0	0	0	Initial		8.2	8.5	92	0	125	
												20 hrs			7.6	90	4	125	
		5.6	10	20	5-20 hrs	-	-	90	90	90	90	Initial	23	8.2	8.4	92	0	120	48 hr. D.O. - 2.8
												96 hrs	24		7.8	90	8	120	
		3.2	10	20	30-45 hrs	-	-	100	90	90	90	Initial		8.4	8.3	90	0	115	48 hr. D.O. - 4.0
												96 hrs			7.9	92	12	115	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.4	8.0	90	2	115	
												96 hrs			7.8	92	6	115	
		Tlm (Median Tolerance Limit) - Per cent Concentration						7.2	7.2	7.2	7.2								
Final Effluent		100																	
(Same as above)												Effluent	23	3.2	9.2	104	0	240	Similar to original effluent except slightly darker
Mixed with		32	2	2	1 hr	1 hr	1 hr	0	0	0	0	Initial		-	-	-	-	-	
still waste (lime)	3-12																		
in proportion to		18	5	10	2 hrs	2 hrs	2 hrs	0	0	0	0	Initial		8.0	8.7	94	0	140	
volume released												2 hrs			8.5	94	0	145		
Fish Added		10	5	10	4-18 hrs	4-18 hrs	4-18 hrs	0	0	0	0	Initial		8.2	8.5	92	0	130	
3:00 PM 3-16												18 hrs			7.7	94	10	135	
		5.6	5	10	24 hrs	89-96 hrs	-	80	80	80	40	Initial	23	8.6	8.4	90	0	125	
												96 hrs	24		7.6	98	6	140	
		Control	5	10	-	-	-	100	100	100	100	Initial		8.6	8.2	90	1	115	
												96 hrs			7.7	96	4	125	
		Tlm (Median Tolerance Limit) - Per cent Concentration						7	7	7	<5.2								
Final Effluent		100																	
(Same as above,												Effluent	23	0.0	8.2	100	6	130	Similar to original effluent Low D.O.
mixed with		32	2	2	1 hr	1 hr	1 hr	0	0	0	0	Initial		-	-	-	-	-	
still waste (no lime)	3-13																		
in proportion to		18	5	10	2 hrs	2 hrs	2 hrs	0	0	0	0	Initial		7.4	8.2	94	2	125	
volumes released												2 hrs			8.1	90	6	120		
Fish Added		10	5	10	4-18 hrs	4-18 hrs	4-18 hrs	0	0	0	0	Initial		8.0	8.2	92	2	120	
3:00 PM 3-16												18 hrs			7.3	90	14	140	
		5.6	5	10	24 hrs	72-89 hrs	-	80	80	60	40	Initial		8.2	8.2	90	2	120	Low D.O.
												96 hrs			7.5	98	8	135	
		Tlm (Median Tolerance Limit) - Per cent Concentration						7	7	6.1	<5.2								

APPENDIX TABLE A3 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS AND SHINERS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$)ppm	VERSENATE HARDNESS ppm.	
Final Effluent	3-20-56	100										Effluent	23	4.8	7.8	100	44	155	Brown
6-hr.Composite																			Oil and medicinal odor
(No lime on still)		32	2	2	1 hr	1 hr	1 hr	0	0	0	0	Initial		-	-	-	-	-	Turbid
In Lab												1 hr		6.8	7.8	88	16	150	
4:00 PM 3-20		18	2	2	3 hrs	3 hrs	7 hrs	0	0	0	0	Initial		-	-	-	-	-	
Fish Added												7 hrs		5.6	7.2	86	16	130	
3:00 PM 3-21		10	5	10	-	-	-	100	100	100	100	Initial	23	8.4	7.9	90	8	120	48 hr.D.O. - 2.6
												96 hrs	24	3.4	7.5	94	10	130	
		5.6	5	10	48 hrs.	-	-	100	80	60	60	Initial		8.4	8.0	90	6	120	48 hr.D.O. - 3.0
												96 hrs		4.4	7.5	96	10	125	
		3.2	5	10	72 hrs	-	-	100	100	80	80	Initial		8.4	8.1	90	4	120	
												96 hrs		5.6	7.6	96	8	125	
		Control	5	10	-	-	-	100	100	100	100	Initial		9.0	8.1	90	2	120	
												96 hrs		5.8	7.3	92	6	120	
		TLm (Median Tolerance Limit) - Per cent Concentration						13.5	13.5	13.5	13.5								
Final Effluent	3-20-56	18	2	2	30 min	30 min	30 min	0	0	0	0	Initial	23	-	-	-	-	-	
(Same as above)												30 min		7.4	7.9	-	-	-	
Shiners		10	2	2	5-20 hrs	5-20 hrs	5-20 hrs	0	0	0	0	Initial		-	-	-	-	-	
(Notropis												20 hrs		0.0	7.2	-	-	-	Low D.O.
Atherinoides)		5.6	5	10	96 hrs	-	-	100	100	100	80	Initial	23	8.0	8.0	-	-	-	
used as test												96 hrs	24	4.2	7.7	50	2	125	24 hr.D.O. - 3.6
fish		3.2	5	10	-	-	-	100	100	100	100	Initial		8.0	8.1	-	-	-	
Fish added												96 ars		5.4	7.8	98	4	120	
11:30 AM 3-22		Control	5	10	-	-	-	100	100	100	100	Initial		9.0	8.1	90	2	120	
												96 hrs		6.2	7.3	92	6	120	
		TLm (Median Tolerance Limit) - Per cent Concentration						7.5	7.5	7.5	7								May be low due to oxygen depletion
Final Effluent	6-19-56	100										Effluent	23	-	8.5	116	0	280	Brown
6-Hr.Composite																			Strong solvent and oil odor
In Lab		18	5	10	1 hr	2 hrs	2 hrs	0	0	0	0	Initial		6.0	8.3	90	1	160	Turbid
4:00 PM 6-19												2 hrs		7.2	8.4	104	0	162	
Fish Added		10	5	10	2 hrs	2 hrs	4 hrs	0	0	0	0	Initial		6.6	8.3	90	1	160	
11:00 AM 6-20												4 hrs		7.0	8.3	94	0	150	
		5.6	5	10	2 hrs	4 hrs	7 hrs	0	0	0	0	Initial		7.0	8.3	90	1	160	
												7 hrs		6.8	8.2	90	0	140	
		3.2	5	10	24 hrs	72 hrs	-	80	60	40	40	Initial	23	7.4	8.3	90	1	160	
												96 hrs	23	4.8	7.7	96	4	135	
		1.8	5	10	-	-	-	100	100	100	100	Initial		7.6	8.2	90	0	135	
												96 hrs		5.2	7.8	96	2	135	
		Control	10	20	-	-	-	100	100	100	100	Initial		7.8	8.2	90	0	130	
												96 hrs		5.8	7.9	94	2	130	
		TLm (Median Tolerance Limit) - Per cent Concentration						3.9	3.5	2.9	2.2								

APPENDIX TABLE A4 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Final Effluent	6-25-56	100										Effluent	23	4.0	8.6	84	0	300	Brown
8-Hr.Composite																			Oil and medicinal odor
In Lab		18	2	2	1-13 hrs	1-13 hrs	1-13 hrs	0	0	0	0	Initial		-	-	-	-	-	Turbid
4:00 PM 6-25														-	-	-	-	-	
Fish Added		10	5	10	6-18 hrs	28-42 hrs	-	60	40	40	40	Initial		7.2	8.3	92	0	145	48 hr.D.O. - 4.0
2:00 PM 6-26												96 hrs.		1.0	7.4	-	-	-	Low D.O.
		5.6	5	10	-	-	-	100	100	100	100	Initial	23	7.6	8.3	94	0	135	
												96 hrs.	23	1.8	7.5	-	-	-	
		3.2	5	10	-	-	-	100	100	100	100	Initial		7.8	8.3	94	0	130	
												96 hrs.		2.0	7.5	-	-	-	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	
												96 hrs.		3.0	7.7	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						11	9.1	9.1	9.1								
Final Effluent	11-13-56	100																	
8-hr.Composite												Effluent	23	-	8.1	94	4	460	Brown
(Continuous)		32	2	2	1 hr	1 hr	2 hrs	0	0	0	0								Solvent and oil odor
In Lab												Initial		-	-	-	-	-	Slight turbidity
5:00 PM 11-13		18	5	10	1 hr	2 hrs	3 hrs	0	0	0	0			-	-	-	-	-	
Fish Added												Initial		6.0	8.3	76	0	180	
9:30 AM 11-15		10	5	10	-	-	-	100	100	100	100	3 hrs		5.4	8.1	-	-	-	
												Initial	23	6.6	8.3	86	0	165	
		5.6	5	10	-	-	-	100	100	100	100	96 hrs	23	4.0	7.9	-	-	-	
												Initial		7.2	8.3	90	0	150	
		Control	5	10	-	-	-	100	100	100	100			-	-	-	-	-	
												Initial		7.8	8.3	90	0	135	
		TLm (Median Tolerance Limit) - Per cent Concentration						13.5	13.5	13.5	13.5				-	-	-	-	
Final Effluent	11-15-56	100																	
8-Hr.composite												Effluent	23	-	8.0	104	6	440	Brown
(Continuous)		32	2	2	1 hr	1 hr	2 hrs	0	0	0	0								Solvent and oil odor
In Lab												Initial		-	-	-	-	-	Slight turbidity
5:00 PM 11-15		18	10	20	5 hrs	5-24 hrs	-	10	10	10	10			-	-	-	-	-	
Fish Added												Initial	23	5.8	8.1	100	4	200	24 hr.D.O. - 4.2
11:15 AM 11-16		10	5	10	-	-	-	100	100	100	100	96 hrs.	23	3.6	7.9	-	-	-	
												Initial		6.2	8.2	96	0	175	
		5.6	5	10	-	-	-	100	100	100	100	96 hrs.		7.2	7.9	-	-	-	
												Initial		6.2	8.3	94	0	155	
		TLm (Median Tolerance Limit) - Per cent Concentration						14	14	14	14			-	-	-	-	-	

APPENDIX TABLE A5 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Final Effluent	11-16-56	100																	
8-Hr.Composite												Effluent	23	-	7.9	92	6	430	Brown
(Continuous)		32	2	2	2 hrs	2 hrs	4 hrs	0	0	0	0								Solvent and oil odor
In Lab												Initial		4.4	8.1	100	6	235	Slight turbidity
5:00 PM 11-16		18	5	10	2-24 hrs	-	-	80	80	80	80								Effluent contained
Fish Added												4 hrs.		4.4	8.1	-	-	-	only a small amount
11:45 AM 11-17		10	5	10	-	-	-	100	100	100	100	Initial	23	5.8	8.2	94	0	210	of caustic wash
												96 hrs.	23	5.4	7.9	-	-	-	
		5.6	5	10	-	-	-	100	100	100	100	Initial		6.3	8.3	92	0	195	
												96 hrs.		13.4	7.4	-	-	-	
												Initial		6.8	8.3	92	0	165	
		Tlm (Median Tolerance Limit) - Per cent Concentration						22.5	22.5	22.5	22.5			-	-	-	-	-	
Final Effluent	12-6-56	18	10	20	5 hrs	7-24 hrs	7-24 hrs	0	0	0	0	Initial		6.4	8.2	92	0	175	
8-Hr.Composite												24 hrs.		3.8	7.5	92	5	190	Effluent contains no
(Continuous)		10	10	20	30 hrs	-	-	100	80	80	80	Initial	23	6.8	8.0	92	0	175	caustic wash
4:00 AM-12 Noon	12-6											96 hrs.	23	4.8	7.5	96	4	165	48-Hr.D.O. - 3.6
Fish Added		5.6	10	20	-	-	-	100	100	100	100	Initial		7.0	8.0	92	0	175	
10:00 AM 12-7												96 hrs.		4.4	7.3	104	6	160	48-Hr.D.O. - 4.1
		Control	5	10	-	-	-	100	100	100	100	Initial		7.4	7.8	96	1	175	
												96 hrs.		4.6	7.9	100	4	170	
		Tlm (Median Tolerance Limit) - Per cent Concentration						13.5	12.3	12.3	12.3								
Final Effluent	12-6-56	18	10	20	20 hrs	24 hrs	44 hrs	20	0	0	0	Initial		6.2	8.5	96	0	165	24-Hr.D.O. - 4.6
8°hr.Composite												44 hrs.		0.3	7.2	92	4	175	Low D.O.
(Continuous)		10	10	20	28 hrs	-	-	100	70	70	70	Initial	23	6.8	8.0	92	0	165	
12N-6PM 12-6												96 hrs	23	3.6	7.8	92	7	165	
Fish Added		5.6	10	20	-	-	-	100	100	100	100	Initial		7.0	8.2	94	0	150	
3:00 PM 12-7												96 hrs.		3.2	7.7	100	9	155	
		Tlm (Median Tolerance Limit) - Per cent Concentration						14.3	12	12	12								
Final Effluent	12-7-56	18	5	10	5 hrs	27-44 hrs	27-44 hrs	60	0	0	0	Initial		7.6	7.2	86	4	165	Low D.C.*
8-Hr.Composite												44 hrs.		0.0	7.1	92	5	185*	Effluent contains no
(Continuous)		13.5	5	10	-	-	-	100	100	100	100	Initial	23	6.0	8.1	90	0	165	caustic wash
4AM-12N 12-7												96 hrs.	23	2.0	6.7	100	9	175	24-Hr.D.O. - 1.4
Fish Added		10	5	10	-	-	-	100	100	100	100	Initial		7.6	7.9	90	2	150	
1:30 PM 12-8												96 hrs.		4.4	7.8	100	4	165	
		5.6	5	10	-	-	-	100	100	100	100	Initial		8.0	7.9	96	2	160	
												96 hrs.		2.4	7.5	102	6	160	
		Tlm (Median Tolerance Limit) - Per cent Concentration						>18	15.5	15.5	15.5								Tlm may be low due to oxygen depletion

APPENDIX TABLE A6 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$)ppm	VERSENATE HARDNESS ppm.	
Final Effluent	12-7-56	18	5	10	5-22 hrs	5-22 hrs	5-22 hrs	0	0	0	0	Initial		7.4	8.2	90	0	165	
8-Hr.Composite												22 hrs.		5.8	7.6	88	5	175	
(Continuous)		13.5	5	10	26-48 hrs	26-48 hrs	-	100	40	20	20	Initial	23	6.4	8.3	92	0	160	48-Hr.D.O. - 5.0
12N-8PM 12-7												96 hrs.	23	4.8	7.0	100	7	160	
Fish Added		10	5	10	48-62 hrs	72 hrs	-	100	100	20	20	Initial		7.6	8.1	92	0	165	48-Hr.D.O. - 2.4
1:30 PM 12-8												96 hrs.		16.0	8.1	96	8	165	
		5.6	5	10	-	-	-	100	100	100	100	Initial		7.8	7.9	96	2	150	48-Hr.D.O. - 3.0
												96 hrs.		4.0	7.8	100	6	160	
		TLm (Median Tolerance Limit) - Per cent Concentration						15.5	12.8	8	8								
Ammonia Still	3-12-56	100										Effluent		0.0	9.7	2120	0	8770	Dark brown Medicinal odor Turbid-Large amount of gray sediment No D.O.
Waste (Lime)																			
8-Hr.Composite		10	2	2	15 min	15 min	15 min	0	0	0	0	Initial		-	-	-	-	-	
7:00 AM to														-	-	-	-	-	
3:00 PM 3-12		3.2	10	20	2 hrs	6 hrs	23 hrs	0	0	0	0	Initial		6.0	8.5	150	0	325	
Fish Added												23 hrs.		3.0	7.8	50	4	300	
11:00 AM 3-13		1.8	10	20	23 hrs	27 hrs	33 hrs	70	0	0	0	Initial		7.2	8.4	130	0	225	
												33 hrs.		2.2	7.6	84	8	225	
		1.0	10	20	55-69 hrs	-	-	100	100	90	90	Initial	23	7.2	8.5	104	0	175	48-Hr.D.O. - 1.4
												96 hrs.	24	5.4	7.8	96	6	200	Aerated after 48 hrs.
		Control	10	20	-	-	-	100	100	100	100	Initial		7.8	8.1	94	0	125	
												96 hrs.		5.4	8.0	94	4	125	
		TLm (Median Tolerance Limit) - Per cent Concentration						2.1	1.35	1.3	1.3								
Ammonia Still	3-13-56	100										Effluent		0.0	7.6	190	650	130	Dark brown Medicinal Odor Turbid
Waste (No Lime)																			
8-Hr.Composite		10	2	2	30 min	45 min	45 min	0	0	0	0	Initial		-	-	-	-	-	
7:00 AM to														-	-	-	-	-	
3:00 PM 3-13		3.2	10	20	1 hr	3 hrs	5 hrs	0	0	0	0	Initial		5.4	7.8	98	24	125	
Fish Added												5 hrs.		6.2	7.8	98	22	125	
11:00 AM 3-14		1.8	10	20	9-21 hrs	9-21 hrs	9-21 hrs	0	0	0	0	Initial		6.4	7.9	98	12	125	
												21 hrs.		4.0	7.4	88	26	125	
		1.0	10	20	9-21 hrs	31 hrs	-	70	50	50	50	Initial	23	7.0	8.0	96	8	125	48-Hr.D.O. - 0.6
												96 hrs.	24	3.8	7.6	90	20	125	Aerated after 48 hrs.
		.56	10	20	48 hrs	-	-	100	90	90	90	Initial		8.2	7.9	90	6	115	48-Hr.D.O. - 1.4
												96 hrs.		3.2	7.8	86	20	120	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.0	8.1	96	1	125	
												96 hrs.		5.4	8.0	94	4	125	
		TLm (Median Tolerance Limit) - Per cent Concentration						1.35	1.0	1.0	1.0								

APPENDIX **TABLE A7 -BIOASSAY DATA**

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Ammonia Still	6-25-56	100										Effluent		0.0	11.3	1520	0	6800	Very dark brown Medicinal and tar odor Turbid
Waste (Lime)																			
8-Hr.Composite		3.2	2	2	1-16 hrs	1-16 hrs	1-16 hrs	0	0	0	0	Initial		-	-	-	-	-	
7:00 AM to																			
3:00 PM 6-25		1.8	5	10	7-19 hrs	7-19 hrs	26-43 hrs	20	0	0	0	Initial		5.6	8.4	80	0	255	24-Hr.D.O. - 2.2
Fish Added												43 hrs.		0.0	7.2	82	6	250	Low D.O.
1:00 PM 6-26		1.0	5	10	7-19 hrs	-	-	80	80	80	80	Initial	23	6.4	8.5	94	0	200	
												96 hrs.	23	2.4	7.3	-	-	-	
		.56	5	10	96 hrs	-	-	100	100	100	80	Initial		6.6	8.7	100	0	185	Toxicity was not decreased when oxygen maintained
												96 hrs.		1.6	7.3	-	-	-	
		Control	10	20	96 hrs	-	-	100	100	100	80	Initial		8.2	8.2	94	0	130	
												96 hrs.		3.0	7.7	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						1.35	1.25	1.25	1.25								
Ammonia Still	11-13-56	100										Effluent		-	9.2	1530	0	-	Dark brown Faint tar and coal gas odor Turbid-grey sediment on bottom
Waste (Lime)																			
8-Hr.Composite		3.2	2	2	1 hr	1 hr	2 hrs	0	0	0	0			-	-	-	-	-	
7:00 AM to																			
3:00 PM 11-13		1.8	5	10	2 hrs	3 hrs	7-22 hrs	0	0	0	0	Initial		5.4	8.4	80	0	250	
Fish Added																			
10:00 AM 11-15		1.0	5	10	7-22 hrs	48-72 hrs	-	80	60	40	40	Initial		5.8	8.5	94	0	215	
												96 hrs.		4.0	7.8	-	-	-	
		.56	5	10	-	-	-	100	100	100	100	Initial		6.6	8.8	106	0	185	
												96 hrs.		3.4	7.9	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						1.25	1.1	0.90	0.90								
Ammonia Still	11-15-56	100										Effluent		-	9.8	1330	0	9540	Dark brown Faint tar and coal gas odor Turbid-grey sediment on bottom
Waste (Lime)																			
8-Hr.Composite		1.8	5	10	4 hrs	4-21 hrs	24-48 hrs	40	0	0	0	Initial		6.0	8.3	90	0	275	
7:00 AM to														4.8	7.5	-	-	-	
3:00 PM 11-15		1.0	5	10	-	-	-	100	100	100	100	Initial	23	6.0	8.6	100	0	225	
Fish Added													23	4.6	7.8	-	-	-	
12 Noon 11-16		.56	5	10	-	-	-	100	100	100	100	Initial		6.4	8.5	92	0	200	
														3.2	7.9	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						1.60	1.35	1.35	1.35								

APPENDIX

TABLE A6 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
East Quench	6-25-56	100										Effluent		3.6	8.0	78	2	240	Dark brown Faint coal gas odor Turbid
Station																			
8-Hr.Composite		56	5	10	5-21 hrs	5-21 hrs	-	40	20	20	20	Initial	23	5.6	8.0	84	2	185	
7:00 AM to																			
3:00 PM 6-25		32	5	10	9-21 hrs	-	-	60	60	60	60	96 hrs.	23	1.4	7.5	-	-	-	48-Hr.D.O. - 4.8
Fish Added												Initial		7.0	8.1	90	2	160	
11:00 AM 6-26		18	5	10	-	-	-	100	100	100	100	96 hrs.		3.4	7.6	-	-	-	No decrease in toxicity when oxygen maintained
												Initial		6.6	8.1	94	1	145	
		10	5	10	-	-	-	100	100	100	100	96 hrs.		2.8	7.6	-	-	-	
												Initial		7.6	8.1	94	1	140	
		Control	10	20	-	-	-	100	100	100	100	96 hrs.		3.2	7.7	-	-	-	
												Initial		8.2	8.2	94	0	130	
		TLm (Median Tolerance Limit) - Per cent Concentration						42	17	17	17	96 hrs.		3.0	7.7	-	-	-	
West Quench	6-25-56	100										Effluent		1.0	7.4	96	8	235	Dark brown Faint coal gas odor Turbid
Station (contains																			
1/2 of light oil		56	5	10	5 hrs	7 hrs	7 hrs	0	0	0	0	Initial		4.6	7.3	98	6	185	
decanter water)												7 hrs.		5.2	-	-	-	-	
8-Hr.Composite		32	5	10	5-21 hrs	24 hrs.	96 hrs	40	20	20	0	Initial	23	5.0	7.9	94	4	165	48-Hr.D.O. - 6.4
7:00 AM to																			
3:00 PM 6-25		18	5	10	-	-	-	100	100	100	100	96 hrs.	23	1.2	7.5	-	-	-	
Fish Added												Initial		4.2	7.9	94	4	155	48-Hr.D.O. - 3.6
11:00 AM 6-26		10	5	10	96 hrs.	-	-	100	100	100	80	96 hrs.		1.2	7.6	-	-	-	
												Initial		5.2	8.0	94	2	140	48-Hr.D.O. - 4.8
		TLm (Median Tolerance Limit) - Per cent Concentration						29	26	26	26	96 hrs.		1.0	7.5	-	-	-	
West Quench	11-13-56	100	5	10	1 hr	2 hrs	3 hrs	0	0	0	0	Initial		2.0	7.4	74	10	330	Dark brown color Faint coal gas odor Slight turbidity
Station (No light												3 hrs.		2.0	7.5	-	-	-	
Oil Decanter)		56	5	10	4-20 hrs	4-20 hrs	4-20 hrs	0	0	0	0	Initial	23	4.6	7.6	86	8	245	
8-Hr.Composite												20 hrs.	23	3.8	7.2	-	-	-	
7 AM-3 PM 11-13		32	5	10	-	-	-	100	100	100	100	Initial		5.6	7.9	90	6	200	
Fish Added												96 hrs.		4.4	7.8	-	-	-	
1:00 PM 11-15																			
		TLm (Median Tolerance Limit) - Per cent Concentration						42	42	42	42								
West Quench	11-15-56	100	5	10	3-18 hrs	3-18 hrs	3-18 hrs	0	0	0	0	Initial		3.0	7.5	80	10	345	Brown Faint coal gas odor Slight turbidity
Station												18 hrs.		3.6	7.6	-	-	-	
8-Hr.Composite		56	5	10	72-96 hrs	-	-	100	100	100	80	Initial	23	5.0	8.0	96	4	205	
7 AM-3 PM 11-15												96 hrs.	23	2.6	7.8	-	-	-	
Fish Added		32	5	10	-	-	-	100	100	100	100	Initial		5.8	8.0	94	4	205	
3:00 PM 11-16												96 hrs.		3.4	7.8	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						75	75	75	70								

APPENDIX TABLE A9 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	P H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Tar Plant	6-25-56	100										Effluent	23	0.0	8.1	112	1	210	Black
Effluent																			Tar odor
8-Hr.Composite		18	5	10	3 hrs	4 hrs	5 hrs	0	0	0	0	Initial		6.0	8.1	100	1	14[illegible]	Slight turbidity
7:00 AM to												5 hrs		6.4	8.2	96	0	135	
3:00 PM 6-25		10	5	10	5-19 hrs	5-19 hrs	24 hrs	0	0	0	0	Initial		6.6	8.2	94	0	135	
Fish Added												24 hrs		0.2	7.4	94	10	140	Low D.O.
1:00 PM 6-26		5.6	5	10	-	-	-	100	100	100	100	Initial	23	6.8	8.2	94	0	130	Toxicity slightly
												96 hrs	23	2.6	7.5	-	-	-	reduced when oxygen
		Control	10	20	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	maintained
												96 hrs		3.0	7.7	-	-	-	
		Tlm (Median Tolerance Limit) - Per cent Concentration						7.5	7.5	7.5	7.5								
Tar Plant	11-13-56	100																	
Effluent												Effluent		-	7.1	88	20	285	Very dark brown
8-hr.Composite		10	5	10	1 hr	2 hrs	7 hrs	0	0	0	0								solvent odor
7:00 AM to												Initial		6.4	8.1	94	4	150	turbid
3:00 PM 11-13		5.6	5	10	24 hrs	-	-	80	80	80	80	7 hrs		6.2	7.9	-	-	-	
Fish Added												Initial	23	6.8	8.2	90	0	135	
10:15 AM 11-15		3.2	5	10	-	-	-	100	100	100	100	96 hrs	23	3.8	7.9	-	-	-	
												Initial		7.0	8.2	90	0	135	
		1.8	5	10	-	-	-	100	100	100	100	96 hrs		4.0	8.0	-	-	-	
												Initial		7.2	8.3	90	0	135	
		Tlm (Median Tolerance Limit) - Per cent Concentration						7.0	7.0	7.0	7.0	96 hrs		-	-	-	-	-	
Tar Plant	11-15-56	100																	
Effluent												Effluent		-	8.2	138	0	305	Black
8-Hr.Composite		10	5	10	2 hrs	3 hrs	3-20 hrs	0	0	0	0								solvent odor
7:00 AM to												Initial		5.6	8.1	106	0	175	turbid
3:00 PM 11-15		5.6	5	10	-	-	-	100	100	100	100	20 hrs		6.0	7.9	-	-	-	
Fish Added												Initial	23	6.4	8.2	98	0	170	
1:15 PM 11-16		3.2	5	10	-	-	-	100	100	100	100	96 hrs	23	9.6	8.0	-	-	-	
												Initial		6.8	8.3	94	0	165	
		Control	5	10	-	-	-	100	100	100	100	96 hrs		2.8	7.8	-	-	-	
												Initial		7.6	8.2	98	2	155	
		Tlm (Median Tolerance Limit) - Per cent Concentration						7.5	7.5	7.5	7.5	96 hrs		5.4	8.0	-	-	-	

APPENDIX

TABLE A10 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Gas Final	6-25-56	100										Effluent	23	0.0	9.2	1645	0	20	Light yellow-brown Strong coal gas odor No turbidity
Cooler Water																			
(Marley Tower)		10	2	2	10 min	10 min	10 min	0	0	0	0			-	-	-	-	-	
Grab Sample																			
9:00 AM 6-25		3.2	2	2	30 min	30 min	40 min	0	0	0	0			-	-	-	-	-	
Fish Added																			
12:00 Noon 6-2		1.8	5	10	1 hr	s	4 hrs	0	0	0	0	Initial		6.4	8.5	120	0	130	
Closed System																			
(Occasional		1.0	5	10	4-20 hrs	28 hrs	28 hrs	60	0	0	0	Initial		6.6	8.4	110	0	130	
intermittent flow)																			
		.56	5	10	4-20 hrs	-	-	80	80	80	80	Initial	23	7.0	8.3	104	0	130	
		Control	5	10	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	
		TLm (Median Tolerance Limit) - Per cent Concentration						1.1	0.70	0.70	0.70								
Gas Final	11-12-56	100										Effluent	23	0.0	9.0	2060	0	40	Grayish-tan Strong coal gas odor Slight turbidity
Cooler Water																			
(Marley Tower)		1.0	5	10	2 hrs	3 hrs	3 hrs	0	0	0	0	Initial		6.6	8.6	112	0	140	
In Lab																			
5:00 PM 11-12		.56	5	10	3-24 hrs	3-24 hrs	3-24 hrs	0	0	0	0	Initial		7.0	8.6	104	0	130	
Fish Added																			
3:30 PM 11-13		.32	5	10	-	-	-	100	100	100	100	Initial	23	7.2	8.5	96	0	130	
		TLm (Median Tolerance Limit) - Per cent Concentration						0.42	0.42	0.42	0.42								
Gas Final	11-16-56	100										Effluent		-	8.9	2900	0	85	Light brown Strong coal gas odor No turbidity
Cooler Water																			
(Marley Tower)		1.0	2	2	30 min	30 min	30 min	0	0	0	0	Initial		6.8	8.5	112	0	165	
In Lab																			
5:00 PM 11-16		.56	5	10	1-24 hrs	1-24 hrs	1-24 hrs	0	0	0	0	30 min		6.8	8.5	-	-	-	
Fish Added												Initial		8.0	8.4	106	0	155	
1:30 PM 11-16		.32	5	10	1-24 hrs	1-24 hrs	24-48 hrs	40	0	0	0	24 hrs		0.2	7.8	-	-	-	Low D.O.
												Initial		6.4	8.3	100	0	145	
		.18	5	10	-	-	-	100	100	100	100	48 hrs		0.0	7.9	-	-	-	Low D.O.
												Initial	23	7.6	8.4	96	0	140	
		TLm (Median Tolerance Limit) - Per cent Concentration						0.29	0.24	0.24	0.24	96 hrs	23	6.0	7.9	-	-	-	
Gas Final	12-11-56	.32	2	2	6-24 hrs	6-24 hrs	6-24 hrs	0	0	0	0	-		-	-	-	-	-	Light brown Strong coal gas odor No turbidity
Cooler Water																			
Grab Sample 12-11		.18	2	2	-	-	-	100	100	100	100	-		-	-	-	-	-	
Fish Added 10 AM	12-14																		
		TLm (Median Tolerance Limit) - Per cent Concentration						0.24	0.24	0.24	0.24								

APPENDIX TABLE A11 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
East Sump	6-25-56	100	5	10	4 hrs	9-21 hrs	-	40	20	20	20	Initial	23	3.8	7.1	110	8	225	Brown
(Benzol Plant												96 hrs	23	6.2	7.8	-	-	-	Faint medicinal odor
Cooling Waters)		56	5	10	9 hrs	-	-	80	60	60	60	Initial		5.4	7.4	106	6	175	Slight turbidity
8-Hr.Composite												96 hrs		4.0	7.6	-	-	-	
7:00 AM to		32	5	10	9 hrs	-	-	80	80	80	80	Initial		7.0	7.6	98	4	155	
3:00 PM 6-25												96 hrs		3.4	7.7	-	-	-	
Fish Added		18	5	10	-	-	-	100	100	100	100	Initial		7.0	7.8	96	2	135	
11:00 AM 6-26												96 hrs		3.0	7.7	-	-	-	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	
												96 hrs		3.0	7.7	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						87	64	64	64								
East Sump	11-13-56	100	5	10	4 hrs	5 hrs	-	20	20	20	20	Initial	23	2.0	7.4	110	12	315	
(Benzol Plant												96 hrs	23	10.6	7.8	-	-	-	
Cooling Waters)		56	5	10	6-21 hrs	-	-	80	80	80	80	Initial		4.8	7.6	100	8	240	
8-Hr.Composite												96 hrs		6.0	7.8	-	-	-	
7 AM-3 PM 11-13		32	5	10	-	-	-	100	100	100	100	Initial		5.0	7.7	100	6	200	
Fish Added												96 hrs		-	-	-	-	-	
12 Noon 11-15		TLm (Median Tolerance Limit) - Per cent Concentration						75	75	75	75								
East Sump	11-15-56	100	5	10	-	-	-	100	100	100	100	Initial	23	2.8	7.1	118	12	305	Brown
(Benzol Plant												96 hrs	23	8.4	7.9	-	-	-	Faint gasoline odor
Cooling Waters)		56	5	10	-	-	-	100	100	100	100	Initial		5.2	7.5	110	8	235	Slight turbidity
8-Hr.Composite												96 hrs		5.0	8.0	-	-	-	
7 AM-3 PM 11-15		32	5	10	-	-	-	100	100	100	100	Initial		6.6	7.7	104	6	200	
Fish Added												96 hrs		-	-	-	-	-	
2:00 PM 11-16		Control	5	10	-	-	-	100	100	100	100	Initial		7.6	8.2	98	2	155	
												96 hrs		5.4	8.0	-	-	-	
		No TLm Value - 100% Survival in 96 hours																	
West Sump	11-12-56	100										Effluent		-	8.4	75	0	90	Light grayish-tan
(Miscellaneous)																			Faint coal gas odor
Excludes light		32	2	2	2-16 hrs	2-16 hrs	2-16 hrs	0	0	0	0	-			-				Slight turbidity
Oil Decanter Water,																			
R.B.Col.Drain		18	5	10	20-24 hrs	30-44 hrs	-	60	20	20	20	Initial	22	7.4	8.3	84	0	120	
and Caustic Wash)												96 hrs	22	4.2	7.6	-	-	-	
Grab Sample		10	5	10	-	-	-	100	100	100	100	Initial		7.6	8.3	86	0	130	
3:00 PM 11-12												96 hrs		3.6	7.6	-	-	-	
Fish Added		5.6	5	10	-	-	-	100	100	100	100	Initial		7.6	8.3	90	0	135	
12:00 Noon 11-13												96 hrs		-	-	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration						20	14.5	14.5	14.5								

APPENDIX

TABLE A12 -BIOASSAY DATA

DON.ER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
West Sump	6-25-56	100										Effluent	23	-	11.2	325	0	40	White emulsified oil appearance Brown oil scum on surface Strong benzene odor Includes R.B.column drain and caustic wash
(Benzol Plant																			
Wastes). Does		3.2	2	2	1-14 hrs	1-14 hrs	1-14 hrs	0	0	0	0								
not include light																			
oil decanter water		1.0	2	2	1-14 hrs	1-14 hrs	1-14 hrs	0	0	0	0								
8-hr.Composite																			
7:00 AM to		.32	5	10	6 hrs	6-18 hrs	-	40	40	40	40	Initial	23	7.2	8.4	96	0	130	24 hr D.O. - 6.2
3:00 PM 6-25												96 hrs	23	2.2	7.4	-	-	-	
Fish Added		.18	5	10	6-18 hrs	6-18 hrs	-	40	40	40	40	Initial		8.0	8.3	94	0	130	
2:00 PM 6-26												96 hrs		2.6	7.5	-	-	-	
		.10	5	10	6-18 hrs	-	-	80	80	80	80	Initial		8.0	8.3	94	0	130	
												96 hrs		2.2	7.5	-	-	-	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	
												96 hrs		3.0	7.7	-	-	-	
		Tlm (Median Tolerance Limit) - Per cent Concentration						0.15	0.15	0.15	0.15								
West Sump	11-13-56	100										Effluent		-	9.2	125	0	125	White emulsified oil appearance. Oil scum on surface. Strong solvent odor. Includes R.B. column drain and caustic wash.
(Benzol Plant																			
Wastes)Includes		3.2	2	2	2 hrs	2 hrs	2 hrs	0	0	0	0								
Light Oil Decanter																			
Water		1.8	5	10	2 hrs	3 hrs	4 hrs	0	0	0	0	Initial		6.6	8.3	90	0	135	
8-Hr.Composite												4 hrs		5.4	8.2	-	-	-	
(Hourly grabs)		1.0	5	10	24 hrs	29-48 hrs	-	80	20	20	20	Initial	23	6.6	8.3	90	0	135	
7 AM-3 PM 11-13												96 hrs	23	5.2	8.0	-	-	-	
Fish Added		.56	5	10	72-96 hrs	-	-	100	100	80	80	Initial		7.0	8.3	90	0	135	
11:30 AM 11-15												96 hrs		3.0	8.0	-	-	-	
		Tlm (Median Tolerance Limit) - Per cent Concentration						1.25	0.80	0.75	0.75								
West Sump	11-15-56	100										Effluent		-	5.3	-	80	225	White emulsified oil appearance. Oil scum on surface. Strong solvent odor. Includes R.B.column drain and caustic wash.
(Benzol Plant																			
Wastes) Includes		1.8	5	10	2 hrs	3 hrs	3-20 hrs	0	0	0	0	Initial		7.0	7.0	138	4	155	
Light Oil Decanter												20 hrs		5.8	7.7	-	-	-	
Water		1.0	5	10	3-20 hrs	3-20 hrs	24-48 hrs	20	0	0	0	Initial		6.0	7.5	106	2	170	
8-Hr.Composite												48 hrs		0.0	7.8	-	-	-	Low D.O.
(15 min.grab)		.56	5	10	3-20 hrs	24-48 hrs	-	60	20	20	20	Initial	23	6.6	8.0	98	2	160	48 hr.D.O. - 4.4
7 AM-3PM 11-15												96 hrs	23	5.4	8.0	-	-	-	
Fish Added		.32	5	10	3-20 hrs	-	-	80	60	60	60	Initial		7.6	8.3	94	0	135	
1:00 PM 11-16												96 hrs		5.6	7.4	-	-	-	
		Control	5	10	-	-	-	100	100	100	100	Initial		7.6	8.2	98	2	155	
												96 hrs		5.4	8.0	-	-	-	
		Tlm (Median Tolerance Limit) - Per cent Concentration						0.64	0.37	0.37	0.37								

APPENDIX

TABLE A13 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	P H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Light Oil	6-25-56	100										Effluent	23	0.0	7.7	36	6	65	Light tan color Some emulsified oil Coal gas odor
Decanter Water																			
8-Hr.Composite		3.2	4	4	6 hrs	6-18 hrs	6-18 hrs	0	0	0	0	Initial		7.6	8.1	94	0	130	
7:00 AM to												18 hrs.		5.0	7.5	-	-	-	
3:00 PM 6-25		1.2	5	10	-	-	-	100	100	100	100	Initial	23	7.6	8.2	94	0	130	24 hr.D.O. - 3.4
Fish Added												96 hrs.	23	2.2	7.5	-	-	-	
3:00 PM 6-26		1.0	5	10	-	-	-	100	100	100	100	Initial		7.8	8.2	94	0	130	
												96 hrs.		2.4	7.6	-	-	-	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	
												96 hrs.		3.0	7.7	-	-	-	
		TLm (Median Tolerance Limit)			- Per cent Concentration			2.4	2.4	2.4	2.4								
Light Oil	11-12-56	100										Effluent	23	-	8.2	50	4	110	Almost clear with whitish cast, some emulsified oil. Strong coal gas and solvent odor.
Decanter Water																			
8-Hr.Composite		5.6	2	2	2 hrs	2 hrs	2 hrs	0	0	0	0	Initial		6.6	8.4	92	0	125	
7:00 AM to												2 hrs.		6.6	8.3	-	-	-	
3:00 PM		3.2	5	10	-	-	-	100	100	100	100	Initial	23	7.2	8.4	90	0	135	
Fish Added												96 hrs.	23	3.4	7.5	-	-	-	
2:00 PM 11-13		1.8	5	10	-	-	-	100	100	100	100	Initial		7.2	8.4	90	0	130	
												96 hrs.		3.2	7.5	-	-	-	
		TLm (Median Tolerance Limit)			- Per cent Concentration			4.2	4.2	4.2	4.2								
Light Oil	11-16-56	100										Effluent	23		8.5	58	0	110	Almost clear with whitish cast. Some emulsified oil. Strong coal gas and solvent odor.
Decanter Water																			
8-Hr.Composite		5.6	2	2	30 min	30 min	30 min	0	0	0	0	Initial		6.4	8.2	94	0	145	
7:00 AM to												30 min.		6.4	8.2	-	-	-	
3:00 PM 11-16		3.2	5	10	1-24 hrs	1-24 hrs	1-24 hrs	0	0	0	0	Initial		6.4	8.2	92	0	170	
Fish Added												24 hrs.		3.4	7.9	-	-	-	
11:45 AM 11-17		1.8	5	10	24-44 hrs		-	100	80	60	60	Initial	23	6.4	8.3	94	0	170	
												96 hrs.	23	2.2	8.0	-	-	-	
		Control	5	10	-	-	-	100	100	100	100	Initial		7.8	8.3	90	0	135	
												96 hrs.		5.4	8.0	-	-	-	
		TLm (Median Tolerance Limit)			- Per cent Concentration			2.4	2.2	2.0	2.0								

APPENDIX

TABLE A14 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE AND PREPARED

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$)ppm	VERSENATE HARDNESS ppm.	
Residue boiler	11-12-56	100										Effluent	23	-	10.6	290	0	45	Thick, white creamy liquid-emulsified oil Coal gas odor
Column Drain																			
Composite while		.18	2	2	2-16 hrs	2-16 hrs	2-16 hrs	0	0	0	0	Initial		-	-	-	-	-	
Draining Tank												16 hrs		3.4	7.7	92	6	135	
3:00 PM 11-12		.10	5	10	7-21 hrs	7-21 hrs	29-44 hrs	20	0	0	0	Initial		7.4	8.2	80	2	135	
Fish Added												44 hrs		1.2	7.4	-	-	-	
11:30 AM 11-13		.056	5	10	7-21 hrs	29 hrs	-	40	20	20	20	Initial	23	7.6	8.2	90	2	135	
												96 hrs	23	3.0	7.2	-	-	-	
		.032	5	10	7-21 hrs	29 hrs	29-44 hrs	60	0	0	0	Initial		7.6	8.3	90	0	135	
												44 hrs		4.0	7.6	-	-	-	
		.018	5	10	6-24 hrs	-	-	60	60	60	60	Initial		-	-	-	-	-	
												96 hrs		2.6	7.9	-	-	-	
		Control	5	10	-	-	-	100	100	100	100	Initial		7.8	8.3	90	0	135	
												96 hrs		5.4	8.0	-	-	-	
		Tlm (Median Tolerance Limit)			- Per cent Concentration			.042	.020	.020	.020								
Residue Boiler	11-16-56	100																	
Column Drain												Effluent		-	10.5	310	0	170	Thick, white creamy liquid-emulsified oil Coal gas odor
Composite while		.10	5	10	3-24 hrs	3-24 hrs	3-24 hrs	0	0	0	0								
Draining Tank												Initial		7.4	8.2	92	0	155	
3:00 PM 11-16		.056	5	10	3-24 hrs	3-24 hrs	24-48 hrs	20	0	0	0	24 hrs		1.4	7.8	-	-	-	
Fish Added												Initial		6.6	8.3	94	0	155	
10 AM 11-17		.032	5	10	3-24 hrs	3-24 hrs	-	40	40	20	20	48 hrs		2.4	7.9	-	-	-	
												Initial	23	7.0	8.3	96	0	145	
		.018	5	10	3-20 hrs	24-48 hrs	-	60	20	20	20	96 hrs	23	4.2	7.9	-	-	-	
												Initial		7.6	8.4	92	0	135	
		.010	5	10	3-20 hrs	-	-	80	80	80	80	96 hrs		5.4	7.8	-	-	-	
												Initial		-	-	-	-	-	
		Tlm (Median Tolerance Limit)			- Per cent Concentration			.024	.013	.013	.013	96 hrs		-	-	-	-	-	
Residue Boiler	12-7-56	100																	
Column Drain												Effluent		-	10.8	160	0	40	Thick, white creamy liquid-emulsified oil Coal gas odor
Composite while		.032	10	20	7-24 hrs	7-24 hrs	-	40	30	30	30								
Draining Tank												Initial	22	7.8	8.3	122	0	166	
8:30 AM 12-7		.018	10	20	30 hrs	-	-	100	90	80	80	96 hrs	22	6.2	7.7	126	6	168	Dilution water was prepared in the laboratory to simulate Lake Erie water
Fish Added												Initial		8.2	8.2	114	0	160	
9:30 AM 12-17		.01	10	20	30-47 hrs	-	-	100	90	90	90	96 hrs		5.2	7.9	124	6	160	
Prepared Water												Initial		7.6	8.1	110	4	152	
		.0056	10	20	-	-	-	100	100	100	10	96 hrs		4.8	7.7	118	6	154	
												Initial		7.6	8.1	114	4	154	
		Control	10	20	-	-	-	100	100	100	100	96 hrs		4.8	7.7	120	6	156	
												Initial		8.0	8.2	118	0	172	
		Tlm (Median Tolerance Limit)			- Per cent Concentration			.022	.016	.014	.014	96 hrs		7.0	8.0	122	6	158	

APPENDIX TABLE A15 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE AND PREPARED

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Caustic Wash	11-12-56	100										Effluent		-	11.5	-	-	-	Black, thick viscous liquid Strong solvent odor
Composite while																			
Draining Tank		.032	2	2	15 min	15 min	30 min	0	0	0	0	-		-	-	-	-	-	
3:00 PM 11-12																			
Fish Added		.010	5	10	2 hrs	3 hrs	4 hrs	0	0	0	0	Initial		6.6	8.6	100	0	135	
11:45 AM 11-13												4 hrs		6.2	8.5	-	-	-	
		.0056	5	10	4-18 hrs	30 hrs	-	60	20	20	20	Initial	23	7.2	8.5	98	0	140	
												96 hrs	23	3.6	7.5	-	-	-	
		.0032	5	10	-	-	-	100	100	100	100	Initial		7.6	8.4	94	0	130	
												96 hrs		3.6	7.5	-	-	-	
		Control	5	10	-	-	-	100	100	100	100	Initial		7.8	8.3	90	0	135	
												96 hrs		5.4	8.0	-	-	-	
		Tlm (Median Tolerance Limit) - Per cent Concentration						.0068	.0046	.0046	.0046								
Caustic Wash	11-16-56	100										Effluent		-	11.5	-	-	-	Black, thick viscous liquid Strong solvent odor
Composite while																			
Draining Tank		.01	5	10	2-24 hrs	2-24 hrs	2-24 hrs	0	0	0	0	Initial		6.4	8.5	94	0	170	
3:00 PM 11-16												24 hrs		4.6	8.1	-	-	-	
Fish Added		.0056	5	10	28 hrs	-	-	100	80	60	60	Initial	23	6.8	8.4	100	0	145	
10:45 AM 11-17												96 hrs	23	4.0	8.0	-	-	-	
		.0032	5	10	48 hrs	-	-	100	80	80	80	Initial		7.0	8.4	100	0	155	
												96 hrs		4.8	8.0	-	-	-	
		Tlm (Median Tolerance Limit) - Per cent Concentration						.0075	.0070	.0062	.0062								
Caustic Wash	12-7-56	100										Effluent		-	11.9	8800	0	350	Black, thick viscous liquid Strong solvent odor Dilution water was prepared in the laboratory to simulate Lake Erie water
Composite while																			
Draining Tank		.016	10	20	1 hr	1 hr	5 hrs	0	0	0	0	Initial		7.2	9.0	130	0	154	
2:45 PM 12-7												5 hrs		6.4	8.9	128	0	154	
Fish Added		.010	10	20	5 hrs	7 hrs	7-22 hrs	0	0	0	0	Initial		7.6	8.7	126	0	156	
9:30 AM 12-17												22 hrs		6.4	8.3	124	0	158	
Prepared Water		.0056	10	20	7-22 hrs	-	-	70	60	60	60	Initial	22	8.0	8.5	118	0	156	
												96 hrs	22	4.0	7.7	122	6	154	
		.0032	10	20	-	-	-	100	100	100	100	Initial		7.8	8.5	122	0	164	
												96 hrs		5.6	7.8	128	6	160	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.0	8.2	118	0	172	
												96 hrs		7.0	8.0	122	6	158	
		Tlm (Median Tolerance Limit) - Per cent Concentration						.0066	.0062	.0062	.0062								

APPENDIX

TABLE A1c -BIOASSAY DATA

DUNBAR-NAOMA COAL CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

Exploratory tests on grab samples of miscellaneous effluents

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	P H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Wash Oil	11-10-56	32	2	2	3-19 hrs	3-19 hrs	3-19 hrs	0	0	0	0								
Decanter Water																			
Grab 3:00 PM 11-10		18	2	2	23 hrs	23 hrs	27 hrs	50	0	0	0								
Fish Added																			
4:00 PM 11-10		10	2	2	-	-	-	100	100	100	100								
		TLm (Median Tolerance Limit)			- Per cent Concentration			18	13.5	13.5	13.5								
Residue Boiler	11-16-56	3.2	2	2	4 hrs	4 hrs	4 hrs	0	0	0	0								
Decanter Water																			
Grab 3 PM 11-16		1.8	2	2	4-22 hrs	4-22 hrs	4-22 hrs	0	0	0	0								
Fish Added																			
1:30 PM 11-30		1.0	2	2	-	-	-	100	100	100	100								
		TLm (Median Tolerance Limit)			- Per cent Concentration			1.35	1.35	1.35	1.35								
Tar Plant	11-16-56	.32	2	2	4-22 hrs	4-22 hrs	4-22 hrs	0	0	0	0								
Decanter Water																			
Composite of		.18	2	2	4-22 hrs	4-22 hrs	4-22 hrs	0	0	0	0								
4 Grabs 7 AM																			
to 3 PM 11-16		.10	2	2	-	-	-	100	100	100	100								
Fish Added 1:30	PM 11-30																		
		TLm (Median Tolerance Limit)			- Per cent Concentration			0.135	0.135	0.135	0.135								
Creosote Plant	12-11-56	1.8	2	2	4-24 hrs	4-24 hrs	4-24 hrs	0	0	0	0								
Decanter Water																			
Grab 12 N 12-11		1.0	2	2	4-24 hrs	4-24 hrs	-	50	50	50	50								
Fish Added																			
1:30 PM 12-17		.75	2	2	-	-	-	100	100	100	100								
		TLm (Median Tolerance Limit)			- Per cent Concentration			1.0	1.0	1.0	1.0								
West Sump	11-16-56	100										Effluent			10.1	200	0	35	White, emulsified oil appearance. Oil scum on surface. Strong solvent odor.
(Includes R.S.																			
Column Drain		3.2	2	2	4 hrs	4 hrs	4 hrs	0	0	0	0	Initial		-	-	-	-	-	
Does not include																			
Light Oil Decanter		1.8	5	10	4 hrs	4 hrs	4 hrs	0	0	0	0	Initial		6.6	8.5	82	0	150	
or Caustic Wash												4 hrs		-	-	-	-	-	
8-Hr. Composite		1.0	5	10	24-48 hrs	-	-	60	60	60	60	Initial		7.6	8.5	92	0	140	
7:00 AM to												96 hrs		4.8	7.7	-	-	-	
3:00 PM 11-16		.56	5	10	24-48 hrs	-	-	80	80	80	80	Initial		7.6	8.5	90	0	135	
Fish Added												96 hrs		5.2	7.8	-	-	-	
1:30 PM 11-18		TLm (Median Tolerance Limit)			- Per cent Concentration			1.4	1.4	1.4	1.4								

APPENDIX

TABLE A17 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	P H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$) ppm	VERSENATE HARDNESS ppm.	
Donner-Hanna Intake	1-19-56	100	10	20	9-22 hrs	9-22 hrs	9-22 hrs	0	0	0	0	Initial	23	6.0	6.8	74	30	245	Greenish gray
8-Hr.Composite												22 hrs.	23	3.0	7.0	66	20	250	Oil and phenol odor
In Lab		75	5	10	5-22 hrs	28-44 hrs	-	60	40	40	40	Initial		5.8	7.0	72	14	215	Turbid
5:00 PM 1-19												96 hrs.		4.6	7.4	74	8	215	
Fish Added		56	10	20	30-48 hrs	-	-	100	80	70	70	Initial		6.4	7.0	80	16	220	
11:30 AM 1-20												96 hrs.		4.2	7.5	82	6	195	
		Control	10	20	-	-	-	100	100	100	100	Initial		7.6	8.2	94	1	122	
												96 hrs.		5.6	7.7	100	2	125	
		Tlm (Median Tolerance Limit) - Per cent Concentration						79	70	69	69								
Donner-Hanna Intake	1-20-56	100	10	20	1-18 hrs.	1-18 hrs	1-18 hrs.	0	0	0	0	Initial	23	4.8	6.8	60	36	265	Greenish brown
8-Hr.Composite												18 hrs.	23	0.2	6.6	54	24	265	Oil and sewage odor
In Lab		75	5	10	4-22 hrs	4-22 hrs	29-46 hrs	20	0	0	0	Initial		5.0	6.8	62	16	235	Turbid
3:00 PM 1-20												46 hrs.		2.6	7.0	68	8	220	Low D.O.
Fish Added		56	10	20	1-18 hrs	24-36 hrs	-	60	40	40	40	Initial		5.8	7.0	72	22	205	
5:00 PM 1-21												96 hrs.		4.8	7.4	74	6	205	
		32	10	20	-	-	-	100	100	100	100	Initial		6.8	7.4	84	4	165	
												96 hrs.		5.0	7.8	94	4	200	
		Control	10	20				100	100	100	100	Initial		7.8	8.1	100	2	130	
												96 hrs.		5.0	7.6	100	6	125	
		Tlm (Median Tolerance Limit) - Per cent Concentration						60	51	51	51								
Donner-Hanna Intake	2-13-56	100	10	20	-	-	-	100	100	100	100	Initial	25	8.0	7.5	70	8	140	Light greyish tan
8-Hr.Composite												96 hrs.	25	3.4	7.5	66	6	130	Faint oil and solvent odor
In Lab		56	10	20	-	-	-	100	100	100	100	Initial		8.0	7.6	86	4	140	Slight turbidity
4:00 PM 2-13												96 hrs.		4.0	7.6	84	6	125	
Fish Added		Control	10	20	-	-	-	100	100	100	100	Initial		7.6	8.2	96	1	135	
12 Noon 2-14												96 hrs.		4.6	7.8	100	6	125	
		No Tlm Value - 100% survival in 96 hrs.																	
Donner-Hanna Intake	3-12-56	100	10	20	79-94 hr.	-	-	100	100	100	90	Initial	23	9.6	7.5	52	4	105	Greyish tan
8-hr.Composite												96 hrs.	24	6.0	7.3	56	4	110	Oil and gasoline odor
In Lab		56	10	20	-	-	-	100	100	100	100	Initial		8.4	7.8	74	4	115	Slight turbidity
5:00 PM 3-12												96 hrs.		6.0	7.5	74	4	120	
Fish Added		Control	10	20	-	-	-	100	100	100	100	Initial		7.8	8.1	94	0	125	
11:00 AM 3-13												96 hrs.		5.4	8.0	94	4	125	
		No Tlm Value - 90% survival in 96 hrs.																	

APPENDIX

TABLE A16 -BIOASSAY DATA

DONNER-HANNA COKE CORPORATION
BUFFALO, NEW YORK

TEST FISH - FATHEAD MINNOWS
DILUTION WATER - LAKE ERIE

SOURCE AND METHOD OF COLLECTION OF SAMPLE	DATE OF COLLECTION	CONCENTRATION TESTED PERCENT	NUMBER OF TEST FISH	VOLUME OF TEST SAMPLE LITERS	TIME OF DEATH			PERCENT SURVIVAL				CHEMICAL AND PHYSICAL DATA							REMARKS
					FIRST FISH	HALF OF FISH	ALL OF FISH	24 HOURS	48 HOURS	72 HOURS	96 HOURS	TIME	TEMP. °C	DISSOLVED OXYGEN ppm.	p H	TOTAL ALK ($CaCO_3$) ppm.	TOTAL ACIDITY ($CaCO_3$)ppm	VERSENATE HARDNESS ppm.	
Donner-Hanna Intake	6-19-56	100	5	10	1 hr.	1½ hrs.	2 hrs.	0	0	0	0	Initial	23	1.4	7.0	114	8	220	Brown
8-hr.Composite												2 hrs.		1.0	7.1	104	30	208	Faint solvent and oil odor
In Lab		56	5	10	1 hr.	4 hrs.	6 hrs.	0	0	0	0	Initial		4.8	6.9	92	8	200	Turbid
4 PM - 6-19												6 hrs.		3.2	7.4	96	12	180	Low D.O.
Fish Added		32	5	10	8 hrs.	9 hrs.	-	40	40	40	40	Initial	23	5.0	7.3	92	8	165	
11:30 AM 6-20												96 hrs.	23	5.8	7.8	92	4	155	
		18	5	10				100	100	100	100	Initial		6.4	7.8	92	4	140	
												96 hrs.		5.6	7.9	96	2	145	
		Control	10	20	96 hrs.	-	-	100	100	100	90	Initial		7.8	8.2	90	0	130	
												96 hrs.		5.8	7.9	94	2	130	
		TLm (Median Tolerance Limit) - Per cent Concentration			29	29	29	29											
Same as above	6-19-56	100	5	10	2 hrs.	4 hrs.	6 hrs.	0	0	0	0	Initial	23	4.0	-	-	-	-	Slight decrease in toxicity when oxygen maintained.
Oxygenated												6 hrs.		13.0	7.2	98	22	225	
Fish Added		56	5	10	4 hrs.	5 hrs.	9-22 hrs.	0	0	0	0	Initial		-	-	-	-	-	
1:00 PM 6-20												22 hrs.		12.4	7.4	94	6	165	
		32	5	10	38-48 hrs.			100	60	60	60	Initial		-	-	-	-	-	
												96 hrs.		6.6	7.8	94	4	155	
Donner-Hanna Intake	6-25-56	100	5	10	1 hr.	3 hrs.	3 hrs.	0	0	0	0	Initial	23	1.6	7.4	90	12	180	Brown
8-hr.Composite												3 hrs.		4.0	7.1	82	16	225	Faint oil and medicinal odor
In Lab		56	5	10	5-17 hrs.	25-41 hrs	-	60	40	40	40	Initial	23	4.6	7.5	92	8	175	Turbid
4:00 PM 6-25												96 hrs.	23	2.8	7.9	-	-	-	
Fish Added		32	5	10	5-17 hrs.	96 hrs.	-	80	60	60	40	Initial		6.0	7.6	94	6	155	
3:00 PM 6-26												96 hrs.		2.2	7.5	-	-	-	
		Control	10	20	-	-	-	100	100	100	100	Initial		8.2	8.2	94	0	130	
												96 hrs.		3.0	7.7	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration			62	42	42	29											
Donner-Hanna Intake	11-13-56	100	5	10	2 hrs.	2 hrs.	3 hrs.	0	0	0	0	Initial		1.4	6.8	72	16	300	Dark brown
8-hr.Composite												3 hrs.		3.2	7.1	-	-	-	Gasoline odor
In Lab		56	5	10	5-21 hrs	5-21 hrs	-	40	40	40	40	Initial	24	3.6	7.1	86	14	240	Slight turbidity
5:00 PM 11-13												96 hrs.	24	7.6	7.8	-	-	-	Possible low D.O.
Fish Added		32	5	10	-	-	-	100	100	100	100	Initial		4.8	7.3	90	8	190	
12:30 PM 11-15												96 hrs.		5.0	7.8	-	-	-	
		TLm (Median Tolerance Limit) - Per cent Concentration			51	51	51	51											
Donner-Hanna Intake	11-15-56	100	5	10	2-16 hrs	-	-	80	60	60	60	Initial	24	0.9	7.2	90	14	320	Brown
8-hr.Composite												96 hrs.	24	7.0	7.9	-	-	-	Faint gasoline odor
In Lab 5 PM 11-15		56	5	10	-	-	-	100	100	100	100	Initial		4.2	7.3	96	10	250	Slight turbidity
Fish Added 3:15 PM 11-16												96 hrs.		4.8	7.7				Low D.O.
		No TLm value - 60% survival in 96 hrs.																	